Module 3 - Advanced Computer Hardware

3.0.1 Introduction

3.0.1.1 Welcome

A Technician's knowledge must extend beyond knowing how to assemble a computer. You need to have in-depth knowledge of computer system architecture and how each component operates and interacts with other components. This depth of knowledge is necessary when you have to upgrade a computer with new components that must be compatible with existing components and also when you build computers for very specialized applications. This chapter covers the computer boot process, protecting the computer from power fluctuations, multicore processors, redundancy through multiple storage drives, and protecting the environment from hazardous materials found inside of computer components.

You will learn about the computer boot process including the power on self-test (POST) conducted by the BIOS. Explore various BIOS and UEFI settings and how they impact this process. You will explore basic electrical theory and Ohm's law and calculate voltage, current, resistance, and power. Power fluctuations can damage computer components so you will learn how to mitigate the risk of power fluctuations with surge protectors, uninterruptible power supplies (UPSs), and standby power supplies (SPSs). You will learn how to provide storage redundancy and load balancing using redundant arrays of independent disks (RAID). You will also learn how to upgrade computer components and configure specialized computers. Finally, after upgrading a computer, technicians must dispose of the old parts properly. Many computer components contain hazardous materials, such as mercury and rare earth metals in batteries and deadly voltage levels in power supplies. You will learn the risks posed by these components and how to dispose of them properly.

In this chapter, there is a lab where you research hardware upgrades to a computer system. You will use several sources to gather information about the computer hardware components and make recommendations for upgraded components. You will also discuss your recommended upgrade choices.

3.1.1 POST, BIOS, CMOS and UEFI

3.1.1.1 Video Demonstration - BIOS - UEFI Menus

Have you ever heard about the unified, extensible, firmware Interface? Maybe not. But I bet you have heard of a UEFI BIOS. Well, UEFI stands for Unified Extensible Firmware Interface. We're going to kick it off here and investigate the UEFI BIOS. I'll do the investigating, and you'll get the tour.

Let's begin. So my computer here has just booted into the UEFI BIOS. Every computer's a little bit different. And they require different key strokes in order to access the BIOS. For example, my computer required me to press the delete key after I first turned it on. So here we are.

This is a real BIOS. Not a simulated BIOS. In the top left corner you can see my motherboards model number, awesome. And my CPU temperature. Right below that, you can even see my motherboard temperature. In the middle here, we can actually see our system time and date. Right below that, we can see the current Firmware of my UEFI BIOS. What I really enjoy though, is in the top right corner of the screen, we're going to see these listed items here in the top.

Here you can view my current CPU which is four CPU cores and six GPU cores. You can view the operating frequency for both my CPU and my RAM. You can also see the total size of the RAM that I've installed in my system. Now remember, this is the UEFI BIOS. What that means is I have a graphical user interface. That includes keyboard and mouse support. This is very different from what we've seen with Legacy BIOS.

To further demonstrate this, look at this horizontal bar right below my system time and date and my CPU and RAM. From left to right, this is my boot order of my computer. What's even more awesome is the fact that I can drag and drop these items anywhere. We will focus on configuration of this though in another video.

So let's take a quick look inside the UEFI BIOS. Let's start by investigating the left side of the screen. Here we will find that we have an area for motherboard settings. Overclocking our system for faster performance in an area called M-flash which allows us to flash our system with an updated UEFI BIOS.

Now on the right side of the screen, we have a section where you can choose different overclocking profiles. We can pre-build these for the right gaming or video editing occasion. Down below that we have a hardware monitor where we can check out the power usage and cooling. We can even have customized fan speeds and even view graphs here.

And lastly, we can visit the Board Explorer. The Board Explorer is awesome because this allows us to have a beautiful and interactive view of what's actually attached to our motherboard. So it's time for the deeper look. So first we'll head over to settings.

In settings, we can look at system settings. Which I can either click on with my mouse or click the enter key. And inside of here we see time and date as well as in text what's connected to my motherboard. In a Firmware version, we next are going to have the advanced area. In the advanced area, we do a lot of fine tuning and control of both the peripherals and the power settings of our motherboard.

Another item we can customize is going to be the boot settings. So I head back out and I go to boot. This is extremely important. This allows us to customize the boot order of our system, both using device preference, and security settings known as secure boot. We'll take a look at that later on. If we go into the security settings though, we can take a look here and see that we have the ability to set an administrator password. This will prevent other people from accessing and modifying our UEFI BIO settings.

Now let's get out of the settings area and let's go all the way over and see overclock. We'll take a quick look at the overclock settings and you can see all the customizations possible here. This allows you to fine tune your machine for the performance that you desire. But this may cause some extra wear and tear in your system due to the increased heat.

Next, we will have the M-flash section. This is where you can utilize tools in order to flash your UEFI BIOS with the latest Firmware. This is commonly done with a USB key or flash drive plugged in. Not too much. Heading to the right side, we'll go over to our overclocking profiles. This is where we can pick what overclocking profile to use that we have pre-built and saved for a given situation. This should be good for gaming or video editing, or maybe even normal computing use.

Last two sections. We'll take trip into the hardware monitor. Here we can look at the CPU fan speed, temperature, as well as case fan speeds. Some UFI will even allow you to set an average temperature you'd like your system to stay at and your cooling fans will react accordingly to do their best to keep your system as close to that target temperature as possible. Love it.

We'll back up and take a look at that Board Explorer. I click on the Board Explorer. This is great. In the Board Explorer, you can get a graphical view of your motherboard. The highlighted sections allow you to hover your mouse over them, and read a description of what is connected to that component.

For example, if I were to take my mouse cursor and I can hover over the RAM slot where my memory is, I can actually see information regarding it. You can see that each RAM slot has a four gig memory chip installed.

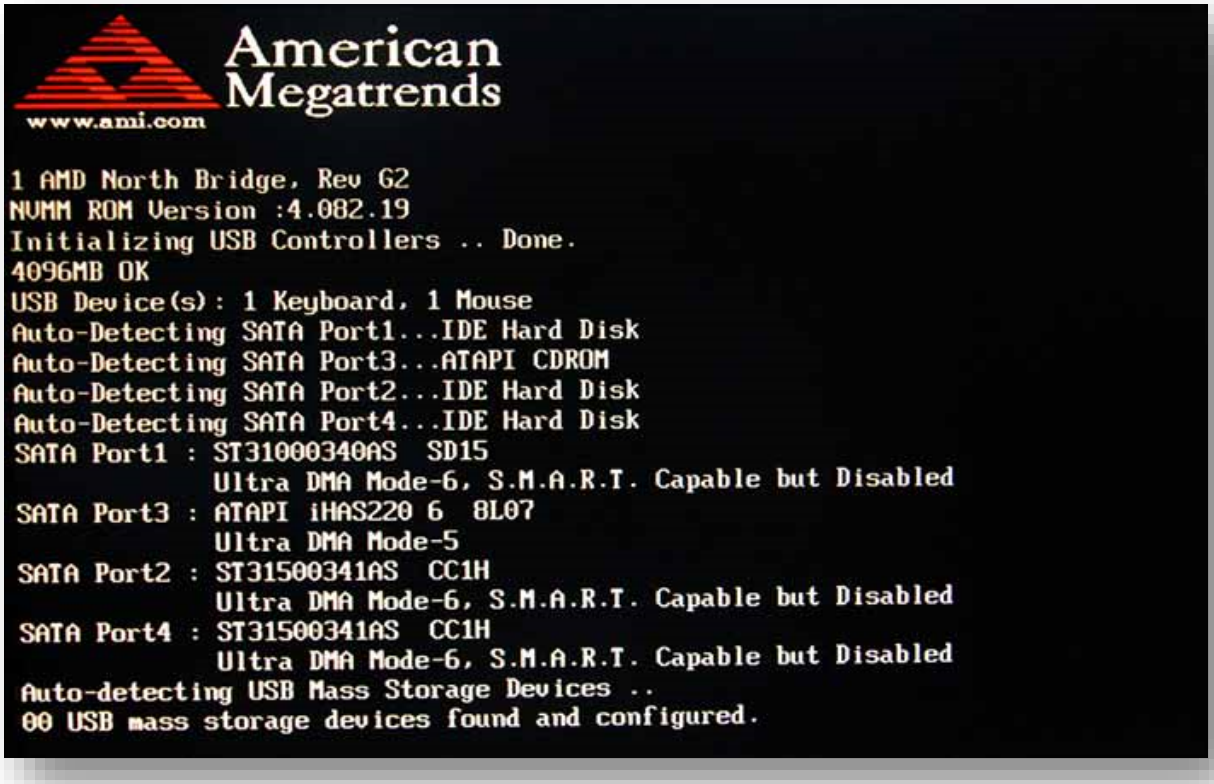
Also if I hover over my SATA ports, we'll get information on what is connected to that individual SATA port. You can see that I have two SATA devices attached. One of these is my device here and the other one is Blu-ray disc DVD-ROM drive. This is a great UFI tool to visually see how the motherboard is arranged and what is connected to your machine without even opening the case.

So if you have time to take, get into your BIOS and view your settings and learn how your device is connected and running.

3.1.1.2 POST

When a computer is booted, the basic input/output system (BIOS) performs a hardware check on the main components of the computer. This check is called a power-on self-test (POST).

The figure below displays a screen capture of a sample POST being performed. Notice how the computer checks whether the computer hardware is operating correctly.


American
Megatrends
www.ami.com
1 AMD North Bridge, Rev G2
NVMM ROM Version :4.082.19
Initializing USB Controllers .. Done.
4096MB OK
USB Device(s): 1 Keyboard, 1 Mouse
Auto-Detecting SATA Port1...IDE Hard Disk
Auto-Detecting SATA Port3...ATAPI CDROM
Auto-Detecting SATA Port2...IDE Hard Disk
Auto-Detecting SATA Port4...IDE Hard Disk
SATA Port1 : ST31000340AS SD15
Ultra DMA Mode-6, S.M.A.R.T. Capable but Disabled
SATA Port3 : ATAPI iHAS220 6 8L07
Ultra DMA Mode-5
SATA Port2 : ST31500341AS CC1H
Ultra DMA Mode-6, S.M.A.R.T. Capable but Disabled
SATA Port4 : ST31500341AS CC1H
Ultra DMA Mode-6, S.M.A.R.T. Capable but Disabled
Auto-detecting USB Mass Storage Devices ..
00 USB mass storage devices found and configured.

Common Beep Codes

Beep Code	**Meaning**	**Cause**
1 Beep (No Video)	Memory Refresh Failure	Bad memory
2 Beeps	Memory parity error	Bad memory
3 Beeps	Base 64 mem failure	Bad memory
4 Beeps	Timer not operational	Bad motherboard
5 Beeps	Processor error	Bad processor
6 Beeps	8042 Gate A20 failure	Bad CPU or Motherboard
7 Beeps	Processor exception	Bad processor
8 Beeps	Video memory error	Bad video card or memory
9 Beeps	ROM checksum error	Bad BIOS
10 Beeps	CMOS checksum error	Bad motherboard
11 Beeps	Cache memory bad	Bad CPU or motherboard

If a device is malfunctioning, an error or a beep code alerts the technician of the problem. If there is a hardware problem, a blank screen might appear at bootup, and the computer will emit a series of beeps.

BIOS manufacturers use different codes to indicate hardware problems. The table below shows a chart of common beep codes. However, motherboard manufacturers may use different beep codes. Always consult the motherboard documentation to get the beep codes for your computer.

Installation Tip: To determine if POST is working properly, remove all of the RAM modules from the computer and power it on. The computer should emit the beep code for a computer with no RAM installed. This will not harm the computer.

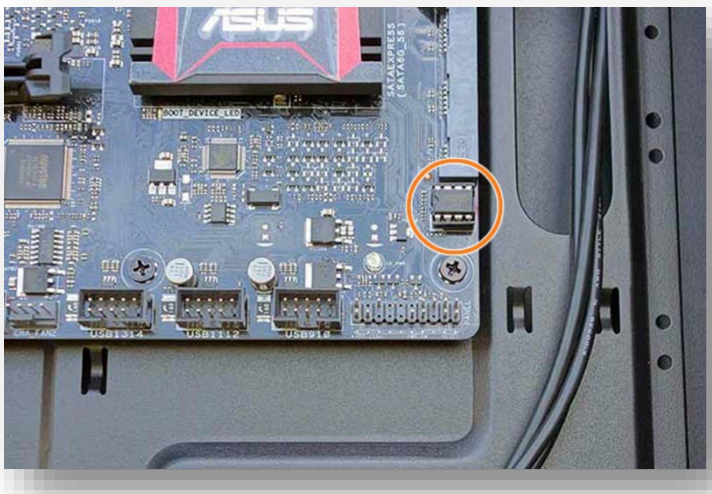
3.1.1.3 BIOS and CMOS

All motherboards need BIOS to operate. BIOS is a ROM chip on the motherboard that contains a small program. This program controls the communication between the operating system and the hardware.

Along with the POST, BIOS also identifies:

- Which drives are available
- Which drives are bootable
- How the memory is configured and when it can be used
- How PCIe and PCI expansion slots are configured
- How SATA and USB ports are configured
- Motherboard power management features

The motherboard manufacturer saves the motherboard BIOS settings in a Complementary Metal Oxide Semiconductor (CMOS) memory chip such as the one shown below.

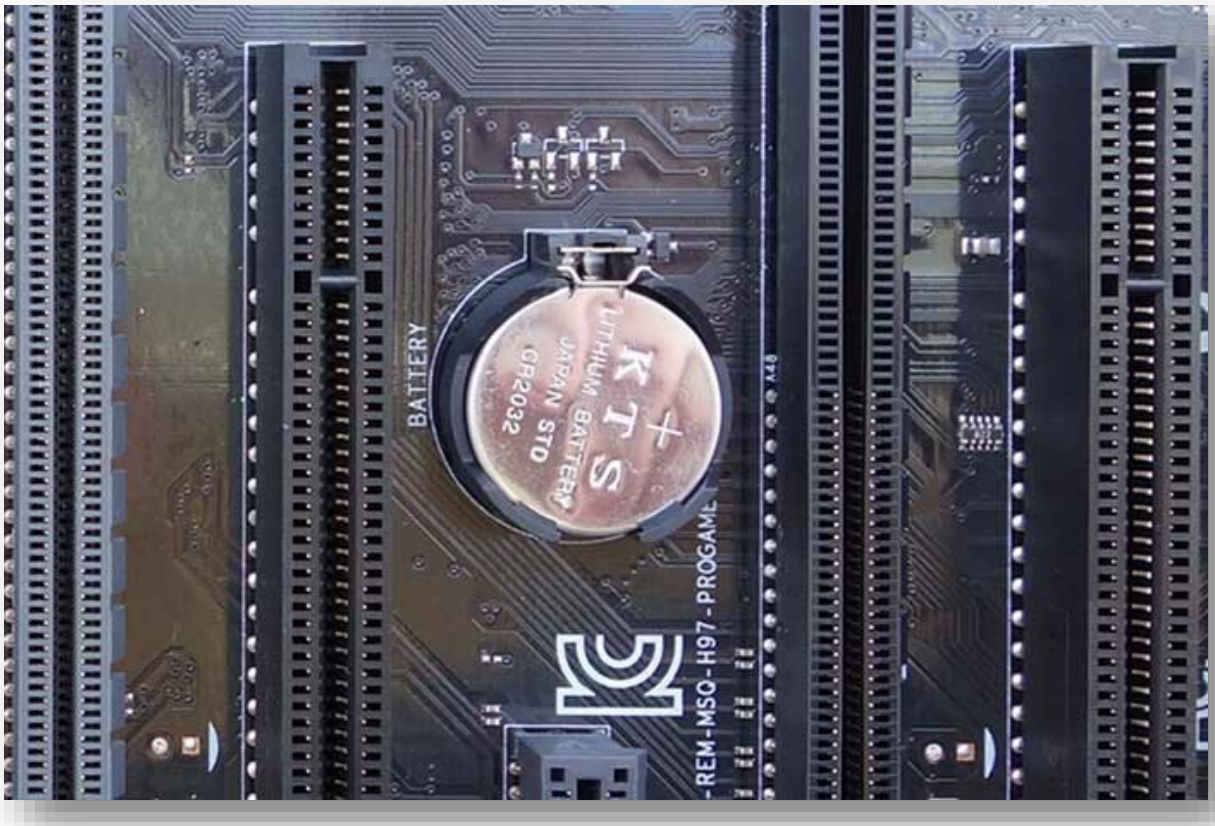


When a computer boots, the BIOS software reads the configured settings stored in CMOS to determine how to configure the hardware.

The BIOS settings are retained by CMOS using a battery, such as the one shown in the figure below. However, if the battery fails, important settings can be lost. Therefore, it is recommended that BIOS settings always be documented.

Note: An easy way to document these settings is to take pictures of the various BIOS settings.

Installation Tip: If the computer's time and date are incorrect, it could indicate that the CMOS battery is bad or is getting very low.



3.1.1.4 UEFI

Most computers today run Unified Extensible Firmware Interface (UEFI). All new computers come with UEFI, which provides additional features and addresses security issues with legacy BIOS. You may see "BIOS/UEFI" when booting into your BIOS settings. This is because Intel chips currently support backwards compatibility with legacy BIOS systems. However, by 2020, Intel will end support for legacy BIOS. For more information, do an internet search for "Intel to remove legacy BIOS".

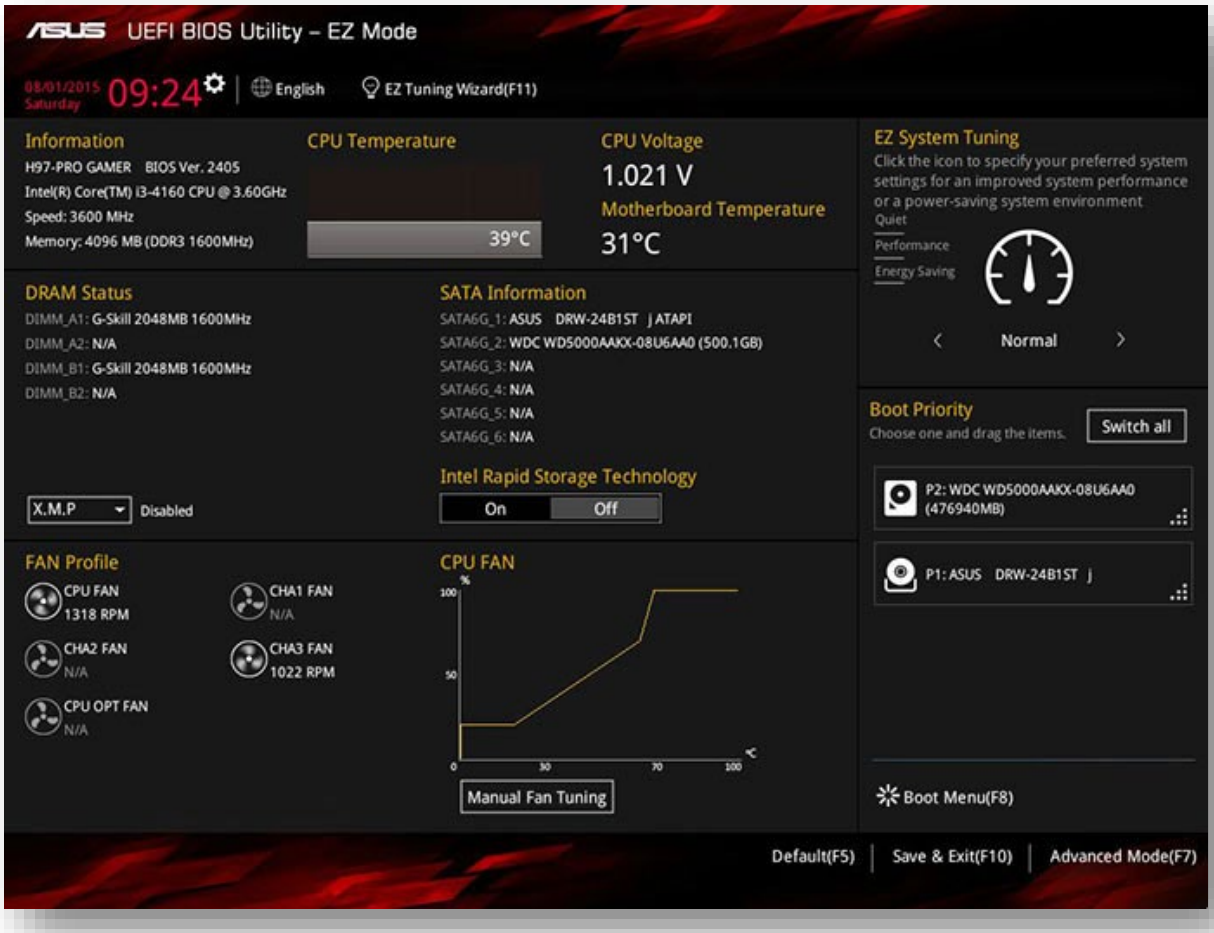
Note: This section uses BIOS, UEFI, and BIOS/UEFI interchangeably. In addition, manufacturers may continue to label their UEFI programs with "BIOS" so that users know it supports the same functions.

UEFI configures the same settings as traditional BIOS but also provides additional options. For example, UEFI can provide a mouse-enabled software interface instead of the traditional

BIOS screens. However, most systems have a text-based interface, similar to legacy BIOS systems.

UEFI can run on 32-bit and 64-bit systems, supports larger boot drives and includes additional features such as secure boot. Secure boot ensures your computer boots to your specified operating system. This helps prevent rootkits from taking over the system. For more information, do an internet search for “Secure boot and rootkits”.

Note: The UEFI setup screens in this section are for reference only and most likely will not look the same as yours. Please consider them as a guide and refer to your motherboard manufacturer documents.



3.1.1.6 Lab - Investigate BIOS or UEFI Settings

Introduction

In this lab, you will boot the computer, explore the firmware setup utility program, and change the boot order sequence.

Recommended Equipment

- Computer with or without operating system
- Motherboard manual

Instructions

Part 1: Enter BIOS or UEFI.

Step 1: Power on the computer.

a. Plug the power supply cable into an AC wall outlet.

b. If there is a power switch on the power supply, set the switch to “1” or “on”.

c. Turn on the computer with the power button on the front panel.

Note: If the computer beeps more than once, or if the power does not come on, notify your instructor.

Step 2: Enter the firmware setup program.

During POST, press the firmware setup key or key combination. The firmware setup utility program screen will appear.

Questions:

What is the key or combination of keys used to enter the firmware setup utility program?

Who manufactures the BIOS or UEFI system for your computer?

What is the BIOS or UEFI version?

Part 2: Explore the Settings.

Step 1: List the main menu options.

Question:

List the main menu options and describe what is monitored in each menu?

Step 2: Find the security settings.

Navigate through each screen to find the security settings. Question:

What security settings and features are available?

Step 3: Find the CPU settings.

Navigate through each screen to find the CPU settings. Questions:

What is the CPU speed?

What other information is listed for the CPU?

Step 4: Find the RAM settings.

Navigate through each screen to find the RAM settings. Questions:

What is the RAM speed?

What other information is listed for the RAM?

Step 5: Find the hard drive settings.

Navigate through each screen to find the hard drive settings. Questions:

What information is listed for the hard drive?

Step 6: Find the boot order sequence.

Navigate through each screen to find the boot order sequence. Questions:

What is the first boot device in the boot order sequence?

How many additional devices can be assigned in the boot order sequence?

Step 7: Set the device boot order settings.

a) Ensure that the first boot order device is the optical drive.
b) Ensure that the second boot order device is the hard disk drive.

Questions:

Why would you change the first boot device to the optical drive?

What happens when the computer boots and the optical drive does not contain bootable media?

Step 8: Find the power management setup or ACPI screen.

Navigate through each screen to find the power management setup screen, or

ACPI screen.

Question:

What power management settings are available?

Step 9: Find the PnP settings.

Navigate through each screen to find the

PnP settings.

Question:

What PnP settings are available?

Step 10: Find the splash screen settings.

Navigate through each screen to find the splash

screen settings.

Question:

What splash screen settings are available?

Step 11: Save and exit the setup utility program.

Save the new BIOS/UEFI settings and exit the setup utility program. The computer should restart automatically.

Note: An error message stating that an OS cannot be found (or a similar error) will appear on the screen after the computer boots. An operating system must now be installed to prevent this error. It is safe to turn off the computer at this time.

3.1.2 BIOS/UEFI Configuration

3.1.2.1 Video Demonstration - Configure BIOS - UEFI Settings

Hello there, we are back in the UEFI files and this time we are here to change some settings. In this video we get to configure the UEFI file, and we are going to explore the following items. We will set up our boot options, customize our security settings, take part in some interface configurations, and even use the firmware backup and update tool.

So let's begin. We want to configure our boot options. Now, you'd think we'd jump straight into motherboard setting and hit boot, but technically we don't even have to go

there. On the main UEFI BIOS screen I can quickly and easily see my boot order listed in this horizontal toolbar.

Now this is awesome because if I want my optical drive to be given more preference in something else, I can just click and drag that optical drive to the front of the list, and now it is being given the first boot order preference. Such as, the optical drive would be booted from before the hard disk drive or USB or anything else. This is great.

Now this feature does depend on you motherboard and UEFI firmware, so let's take a look at the official method as well. We'll go into settings, then I can go ahead and click on boot and inside of here we will see this massive list. Now before we just dive into this list, I like to take note of the boot mode select. With boot mode select here, I see that the default option is Legacy+UEFI. It has been predicted that in the next couple of years, legacy will no longer exist. It is here at this time to allow our board to be backward compatible with devices that require legacy BIOS settings. If you'd like to, you select the options and you'd actually be able click UEFI only, as long as you know your devices will still be supported. Let's continue.

So down below is my list, my current boot option #1 is set as my optical drive, UEFI CD/DVD. That's from my previous drag and drop maneuver. To modify this list you can just click on any one of these items, such as, for example, boot option 1 and I can choose what device will be booted first. For example, I want my USB key. There we go, and now that's first. You see that horizontal list from left to right has changed up above. We'd also go on and click any one of these items and use the plus or minus arrows to move them up or down on the list as well. I personally like the drag and drop option we saw previously.

Next it is time to take a look at some security settings. Back to motherboard settings and then into security. We can find some important settings that we can configure. Here in the security settings, let's take a look at the passwords. The administrator password can be set to prevent other people from accessing and changing your BIOS settings. I'll click enter, and we are going to make this thing, Who, there is already a password on it. It was cisco. We're going to make it cisco again. Create new password, cisco. Confirm new password, cisco. And now our administrator password is cisco. If you want to change and save our BIOS, you're going to need that password of cisco to do it. Now the user password down below, this is special. This can be set in order to prevent the operating system from loading on your machine until a user has entered the correct user password, stored here in BIOS.

Further, there is a feature called U-key. The U-Key feature allows the BIOS Administrator to dedicate a password to a specific USB key or flash drive. The USB key or flash drive will be needed to be plugged into your machine when a user wants to access the operating system of the machine. Wow, never knew a USB flash drive could be so important.

Let's continue on and take a look at some of the interface configuration settings. In the main settings area we are going to go into advanced. Inside of advanced, we are going to access the integrated peripherals. Within the integrated peripherals we are going to find a good amount of settings to control.

In this section, we have the ability to control the onboard LAN controller. This is our physical network heart of the device. We can actually disable it here if we don't want to use it. We can take a look at WiFi and Bluetooth controller. We can also control if the WiFi and Bluetooth components are allowed to be used on the computer. Think of this as using software to

disable individual hardware components on the physical computer before the operating system even got a chance to use it, this is awesome.

We can even make changes to how the SATA hard drives are going to be viewed. For example, I can click enter on SATA mode. We had these SATA hard drives in the legacy IDE mode, current AHCI mode, or even by utilizing RAID. On top of all that, down below we can customize if the SATA connections are allowed to be hot swappable as well.

Let's back up a little bit and take a look at some USB configuration. In settings, advanced, USB configs, you want to take a look here and see that we can actually control both legacy USB support, as well as disabling or enabling the USB controller itself. With this coming into mind, I want you to imagine this machine being at a high risk or high profile environment, and you have to be the IT professional that is concerned about bringing in external USB flash drives. Problem identified and problem solved.

Let's take a step back. Now what we want to take a look at is our Windows configuration. Right here, in the Windows configuration, we can control how quickly our machine will boot. We can do this by activating fast boot, or by activating MSI fast boot. These will allow your system to come online more quickly by skipping some of the more thorough post verification tasks.

Next, we want to talk about what makes our machine boot in the morning, and that is our wake up event settings. We can click on this item to control what is allowed to wake up our computer and turn it on. There is couple here, not too many. We have one last action to cover in this video, and we are going to go all the way back and we're going to head over to M-Flash.

M-Flash is all about firmware updates for our UEFI files. We will have the ability to save our current BIOS to a USB flash drive that is plugged in. This will allow us to restore it at a later date. We also have the ability to update the BIOS using this tool. So, for example, I can click save BIOS to storage. And there is my disk which I can click on, delete the default, and it is saving it to my USB flash drive.

By using the update BIOS feature, we can load a BIOS file that on a USB flash drive that is plugged into our machine. Now this is going to be because this is your storing and recovery, especially when you have settings that you are concerned about and concerned about losing and not having in the future. We can use the update BIOS feature to actually select a file off of the USB thumb drive. And here I had a BIOS ready to go. I can click on the UEFI flash thumb drive and be able to update the BIOS itself.

Now, while every UEFI BIOS will be little bit different you should have a much better understanding of how to configure some of the important settings within your UEFI BIOS.

3.1.2.2 BIOS and UEFI Security

The legacy BIOS supports some security features to protect the BIOS setting. UEFI adds additional security features. These are some common security features found in the BIOS/UEFI systems:

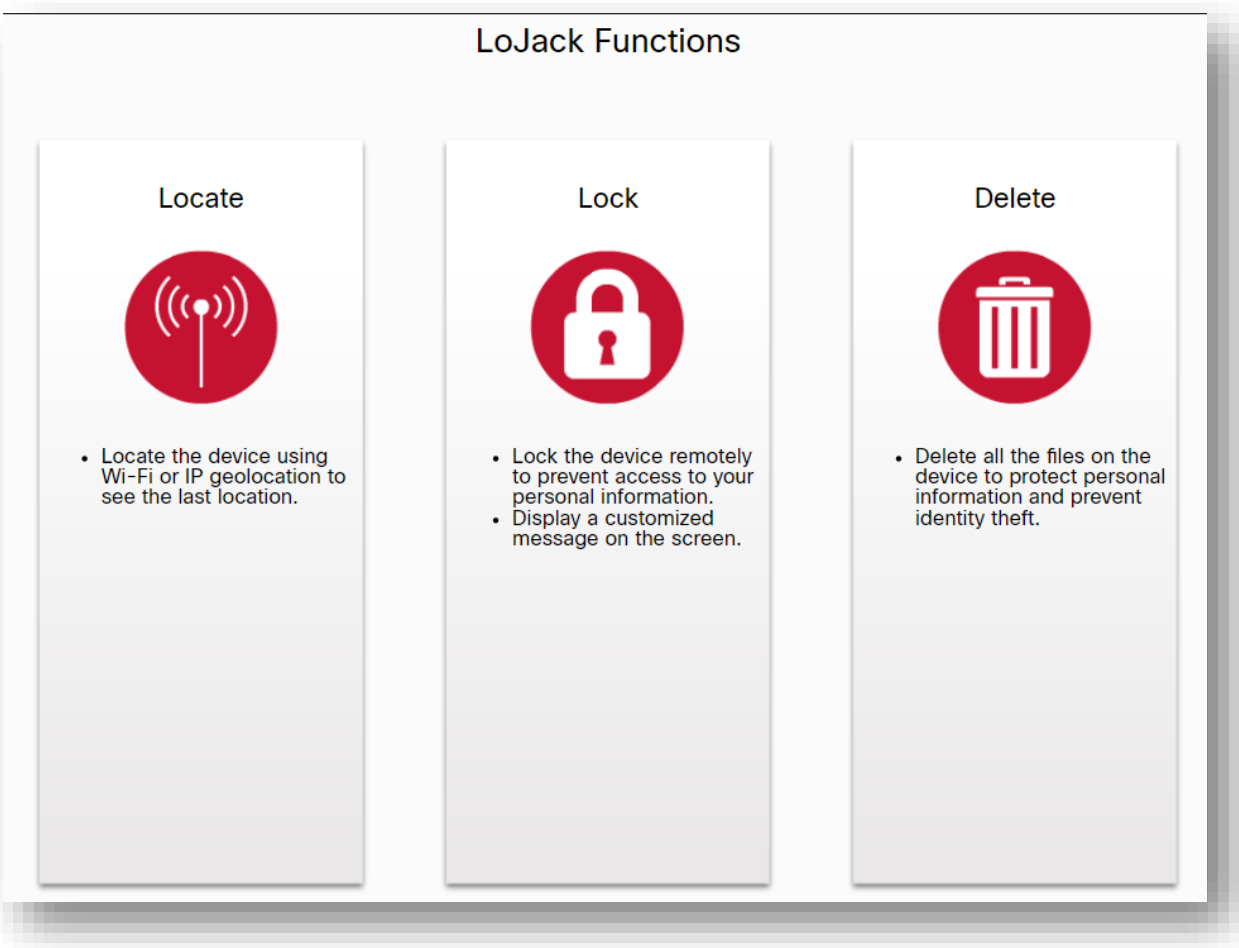
- **Passwords** - Passwords allow for different levels of access to the BIOS settings. Usually, there are two password settings that can be altered; the Supervisor Password and the User Password. The Supervisor Password can access all user-access

passwords and all BIOS screens and settings. The User Password gives access to the BIOS based on a defined level. The table below displays common levels of user access to BIOS. The Supervisor Password must be set before the User Password can be configured.

Access Levels

Access Level	Level Description
Full Access	All screens and settings are available, except the supervisor password setting.
Limited Access	Changes can be made to certain settings only, for example, the time and date.
View Only Access	All screens are available, but no settings can be changed.
No Access	No access is provided to the BIOS setup utility.

- **Drive encryption** - A hard drive can be encrypted to prevent data theft. Encryption changes the data on the drive into code. Without the correct password, the computer cannot boot and data read from the hard drive cannot be understood. Even if the hard drive is placed in another computer, the data remains encrypted.
- **LoJack** – This is a security feature that consists of two programs; the Persistence Module and the Application Agent. The Persistence Module is embedded in the BIOS while the Application Agent is installed by the user. When installed, the Persistence Module in the BIOS is activated and cannot be turned off. The Application Agent routinely contacts a monitoring center over the internet to report device information and location. The owner can perform the functions described in the figure below.


LoJack Functions
Locate
Locate the device using Wi-Fi or IP geolocation to see the last location.
Lock
Lock the device remotely to prevent access to your personal information.
Display a customized message on the screen.
Delete
Delete all the files on the device to protect personal information and prevent identity theft.

- **Trusted Platform Module (TPM)** – This is a chip designed to secure hardware by storing encryption keys, digital certificates, passwords, and data. TPM is used by Windows to support BitLocker full-disk encryption.
- **Secure boot** - Secure Boot is a UEFI security standard that ensures that a computer only boots an OS that is trusted by the motherboard manufacturer. Secure boot prevents an "unauthorized" OS from loading during startup.

3.1.2.3 Update the Firmware

Motherboard manufacturers may publish updated BIOS versions to provide enhancements to system stability, compatibility, and performance. However, updating the firmware is risky. The release notes, such as those shown in the figure, describe the upgrade to the product, compatibility improvements, and the known bugs that have been addressed. Some newer devices operate properly only with an updated BIOS installed. You can usually find the current version on the main screen of the BIOS/UEFI interface.

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FEATURES ADDED

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Build 0027:

- Add ‘Power On' option into BIOS ‘Power Loss Control’.

Build 0026:

- None.

Build 0025:

- Add the function "CPU Swapping".
- Remove the function "Fan Control”.
- Add the customer's feature "EtherBoot”

Note: Reserve two blocks "FFFOOOOOh - FFFOFFFFh” and "FFFi0000n - FFFIFFFF"
in the flash ROM to support the feature "EtherBoot”.
The special OPROM of NIC 82540 should be only placed in the block "FFFOOOOOh - FFFOFFFFh".
The special OPROM of NIC 82550 should be only placed in the block "FFF10000h - FFFFFFFh".

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ISSUES FIXED

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Build 0027:

- System hangs at POST code 67 sometimes during Windows* 2000 continuous reboot test (Vith new 2.4G/533FSB CPU, 80532KEO561M).
- Upgrade the micro code for D-1 and M-O stepping CPU.

Build 0026:

- Defect ID 65139, [XX] - SR1350-E Mitsumi Slimline CD-ROM fails on with certain multi-adapter backplane (Note two types exist) - one works, the other is not recognized.
- Upgrade the micro code for D-1 and M-O stepping CPU to support Intel(r) Xeon(tm)

3.2 Ghz 2M L3 cache based processors.

a. D-1 stepping CPU

Before updating motherboard firmware, record the manufacturer of the BIOS and the motherboard model. Use this information to identify the exact files to download from the motherboard manufacturer's site. Only update the firmware if there are problems with the system hardware or to add functionality to the system.

Early computer BIOS information was contained in ROM chips. To upgrade the BIOS information, the ROM chip had to be physically replaced, which was not always possible. Modern BIOS chips are Electronically Erasable Programmable Read Only Memory (EEPROM) which can be upgraded by the user without opening the computer case. This process is called flashing the BIOS.

To download a new BIOS, consult the manufacturer's website and follow the recommended installation procedures. Installing BIOS software online may involve downloading a new BIOS file, copying or extracting files to removable media, and then booting from the removable media. An installation program prompts the user for information to complete the process.

Many motherboard manufacturers now provide software to flash the BIOS from within an operating system. For example, the ASUS EZ Update utility automatically updates a motherboard's software, drivers, and the BIOS version. It also enables a user to manually update a saved BIOS and select a boot logo when the system goes into POST. The utility is included with the motherboard, or it can be downloaded from the ASUS website.

CAUTION: An improperly installed or aborted BIOS update can cause the computer to become unusable.

3.1.2.5 Lab - Search for BIOS or UEFI Firmware Updates

Introduction

In this lab, you will identify the current BIOS or UEFI version, and then search for BIOS or UEFI update files.

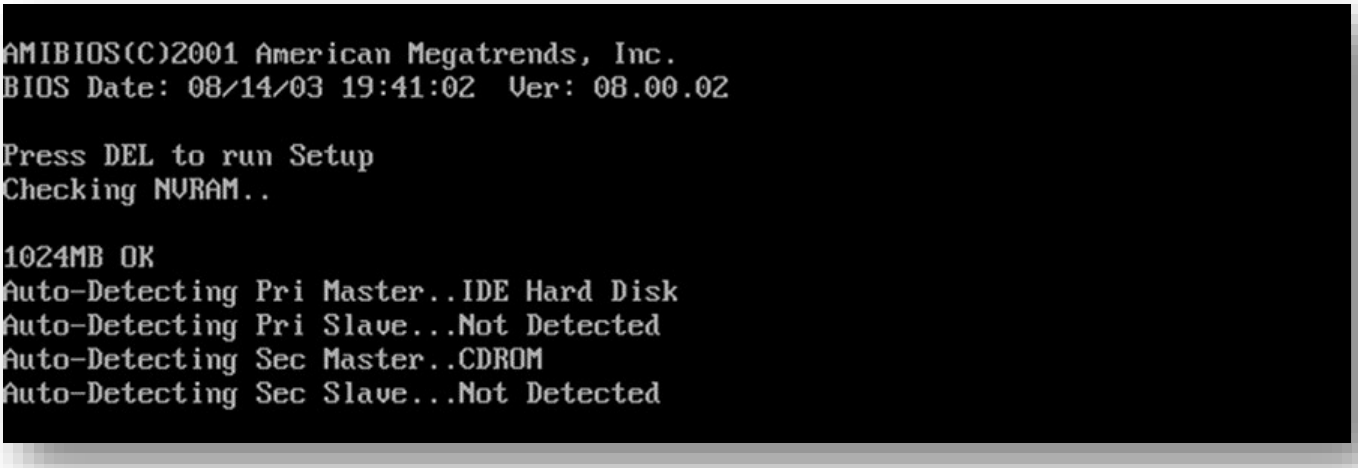
Recommended Equipment

- Classroom computer with an operating system installed
- Internet access

Instructions

Step 1: Boot your computer.

During POST, BIOS information is displayed on the screen for a short period of time.



Do not log on to Windows.

Question:

What key or combination of keys is used to run Setup on your computer?

Step 2: Restart your computer and enter Setup.

The BIOS Setup Utility or UEFI screen appears.

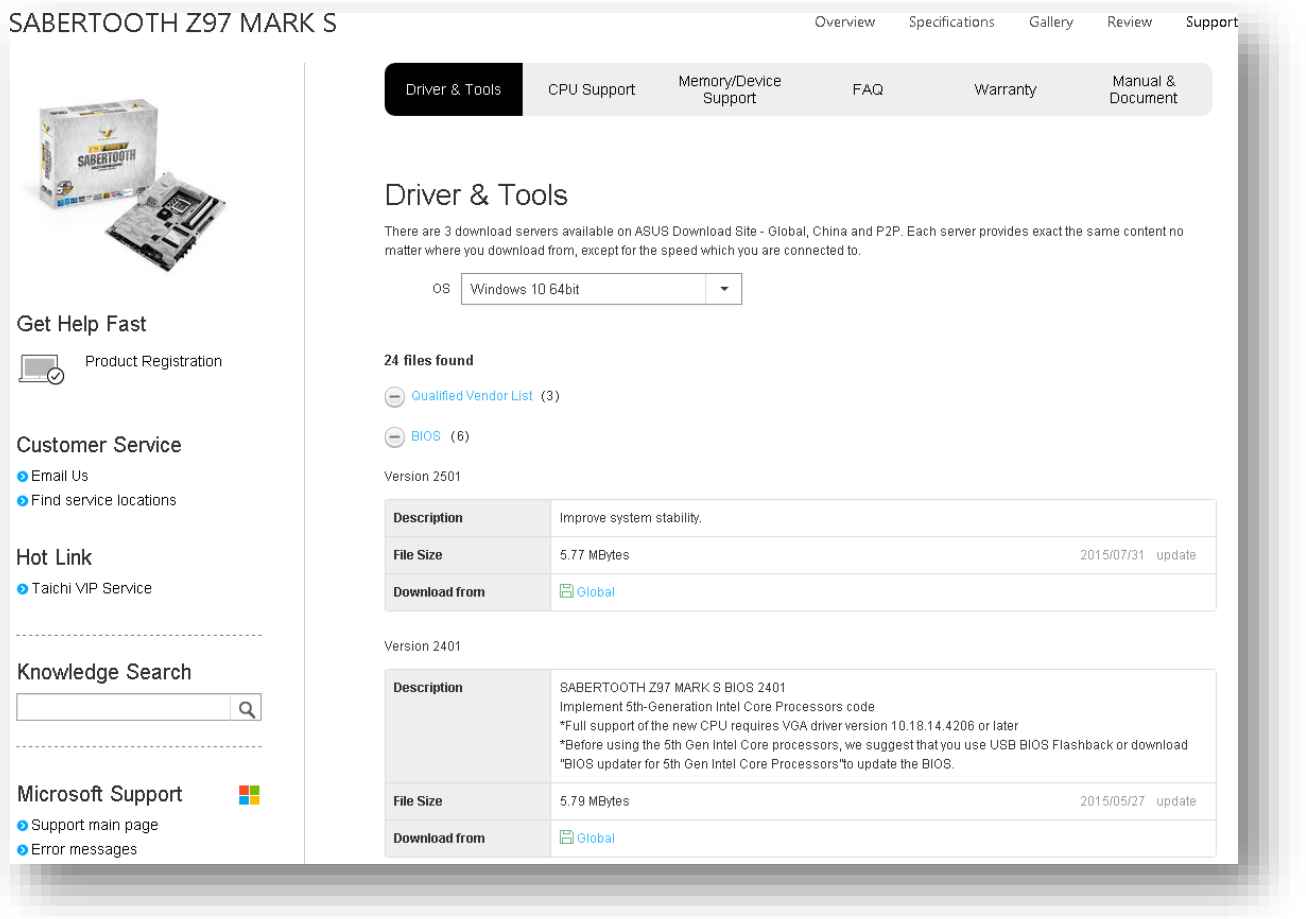
Questions:

Who is the manufacturer of the BIOS?

Which BIOS version is installed in your computer?

Step 3: Search the Internet to find the most current version of BIOS for the motherboard.

Use the information from the previous step to search the Internet to find the most current version of the BIOS for the motherboard in your computer. The following screen is an example of the type of information you would look for to answer the questions below.



Caution: Do not update your BIOS at this time.

Questions:

What is the current BIOS version available for the motherboard?

What features, if any, have been added to the new BIOS version?

What changes, if any, have been made to the new BIOS version to fix problems?

What are the instructions to update the new BIOS version?

3.1.2.6 Lab - Install Windows

Objectives

In this lab, you will install Windows 10.

Background / Scenario

In order to complete many of the remaining labs in this course, you will need to use Windows. This lab provides a basic installation in order to get Windows up and running on the lab PC.

Required Resources

- A computer with a blank hard disk drive
- Windows 10

Instructions

Step 1: Starting the Installation Media

a. Insert the Windows 10 installation DVD into the DVD-ROM drive or plug the USB flash drive into a USB port.

b. When the computer starts up, watch for the message **Press any key to boot from CD or DVD.**

If the message appears, press any key on the keyboard to boot the computer from the DVD. If the **press any key message** does not appear, the computer automatically starts loading files from the DVD.

The computer starts loading files from the DVD or USB flash drive.

Step 2: Configuring Initial settings

a. The **Windows Setup** window opens. Click **Next** to continue unless you need to change the default settings.

b. Click **Install now** to continue the installation.

Step 3: Collecting Information

a. In the Enter the product key to activate Windows window, enter the product key.

Note: You can find the product key on the case or sleeve in which the Windows DVD was packaged, or you can get it from your instructor.

b. In the **License terms** window, read and confirm that you accept the license by selecting the box **I accept the license terms**. Click **Next**.

c. In the Which type of installation do you want? Window, click Custom: Install Windows only (advanced).

d. In the **Where do you want to install Windows?** Window, select the hard drive or partition on which Windows will be installed. In this example, click to select **Disk 0 Unallocated Space**. Click **Next** to continue. Setup has finished collecting information for the installation.

Step 4: Installing Windows

a. The **Installing Windows** window opens. Windows will take some time to copy the files and install the OS on your computer. During the setup, the computer will restart several times.

b. When the **Windows needs to restart to continue** window opens, your computer will automatically restart or you can click **Restart now**.

c. If you get the message **Press any key to boot from CD or DVD…**, do not press

any key and Windows will boot from the hard disk to continue the installation.

Step 5: Basics Setup

In this step, you will select your region and your keyboard layer.

Note: The personalization sub steps maybe different depending on your Windows version.

a. Verify the region and select **yes**. If not, choose your region and select **yes**.

b. Verify the keyboard layout and select **yes**. If not, choose your keyboard layout and select **yes**.

c. Click **Skip** if you are not adding a second keyboard layout. Otherwise, click **Add layout** and answer the prompts to add a second layout.

Step 6: Network Setup

In this step, the installation may continue without your input. If prompted, provide the installation with the necessary information.

Select **Set up for personal use**. Click **Next** to continue. Your instructor may ask you to choose to select **Set up for an organization**.

Step 7: Account Setup

In this step, you will set up a local account to access the computer. You will not be creating a Microsoft account for this exercise. If you already have an account or choose to do so, you may use your Microsoft account for this step.

Note: The account setup sub steps maybe different depending on your Windows version.

a. Click **Offline account** to create a local account. If you already have a Microsoft account and choose to use it, enter the required information and click **Next** to continue.

b. Click **No** to continue using a local account, instead of Microsoft account.

c. Enter a username and click **Next** to continue.

d. Create a password and confirm the password when prompted. Click **Next** to continue.

e. Answer all the security questions and click **Next** to continue.

Step 8: Services Setup

In this step, you can give permission to use Cortana and select your privacy settings.

a. You can choose to use Cortana as your personal assistant. Click **Yes** or **No** to continue.

b. Read the privacy settings and click **Learn More** to find out more details. Then decide which features to use and click **Accept** to continue.

Step 9: Finishing the Installation

a. When you are finished with the installation, Windows continues to finalize your settings.

b. After the installation is completed, the Desktop displays and you are logged into Windows for the first time.

3.1.2.7 Lab - Install Third-Party Software in Windows

Introduction

In this lab, you will install and remove a third-party software application supplied by your instructor. You will install the Packet Tracer Windows application.

Recommended Equipment

The following equipment is required for this exercise:

- A computer with Windows installed
- A flash drive or CD with the latest Packet Tracer Windows install package

Instructions

Part 1: Installing Third-Party Software

Step 1: Locate the installer.

a. Log on to the computer with the Administrator account and use File Explorer to navigate to the folder where the Packet Tracer installer is located. This folder could be on the local hard drive, on an external flash drive or on a CD.

b. Unzip the file as necessary. Locate the Packet Tracer application. The filename is in a form similar to PacketTracer_???_Windows_##bit.exe, where ?? is version number and ## is either 32 or 64.

Step 2: Run the Installer to install Packet Tracer.

a. Start the installation process of the Packet Tracer application. When prompted, click **Yes** to allow this app to make changes to your device.

b. The **License Agreement** window opens. Select **I accept the agreement,** and then click **Next**.

c. The **Select Destination Location** window opens. Keep the default settings and click **Next**. What is the default installation location for Packet Tracer?

d. The **Select Start Menu Folder** window opens. Keep the default settings. Click **Next**.

e. The **Select Additional Tasks** window opens. Keep the default settings. Click **Next**.

f. The **Ready to Install** window opens. Click **Install**.

g. The **Installing** progress window opens to show the progress of the installation.

h. In the **Completing the Cisco Packet Tracer Wizard** window, click **Finish**.

i. Be ready to provide your netacad.com credentials when Packet Tracer opens for the first time.

When Packet Tracer opens, provide your Networking Academy or Skills for All user credentials to continue.

Part 2: Uninstalling Third-Party Software

a. To uninstall a program, click **Control Panel > Programs and Features**. Choose **Cisco Packet Tracer** in the list and right-click **Uninstall**.

b. The **Cisco Packet Tracer Uninstall** window opens. Click **Yes** to confirm the removal.

c. When the successfully removed from your computer message opens, click **OK**.

d. Verify the application was removed. After the application removal process, the **Programs and Features**

window no longer shows Cisco Packet Tracer in the list. Close all open windows.

e. Future activities in this course will require the use of Packet Tracer. Reinstall Packet Tracer.

Reflection Question

Why does Microsoft recommend using Uninstall or change a program to remove an installed application?

3.2.1 Wattage and Voltage

3.2.1.1 Wattage and Voltage

Power supply specifications are typically expressed in watts (W). To understand what a watt is, refer to the interactive image which describes the four basic units of electricity that a computer technician must know.

A basic equation, known as Ohm's Law, expresses how voltage is equal to the current multiplied by the resistance: **V = IR**. In an electrical system, power is equal to the voltage multiplied by the current: **P = VI**.

Measured in Volts (V)

- This is a measure of work required to move a charge from one location to another.
- A computer power supply usually produces several different voltages.

Measured in Ohms (Ω)

- This refers to the opposition to the flow of current in a circuit.
- Lower resistance allows more current to flow through a circuit.
- A good fuse has low resistance or almost 0 ohms.

Measured in Amperes, or Amps (A)

- This is a measure of the amount of electrons moving through a circuit per second.
- Computer power supplies deliver different amperages for each output voltage.

Measured in Watts (W)

- This is a measure of the work required to move electrons through a circuit (voltage), multiplied by the number of electrons going through that circuit per second (current).
- Computer power supplies are rated in watts.

3.2.1.2 Power Supply Voltage Setting

On the back of some power supplies is a small switch called the voltage selector switch, as shown in the image. This switch sets the input voltage to the power supply to either 110V / 115V or 220V / 230V. A power supply with this switch is called a dual voltage power supply. The correct voltage setting is determined by the country where the power supply is used. Setting the voltage switch to the incorrect input voltage could damage the power supply and other parts of your computer. If a power supply does not have this switch, it automatically detects and sets the correct voltage.

CAUTION: Do not open a power supply. Electronic capacitors located inside of a power supply can hold a charge for extended periods of time.

For more information about power supplies, click here.

Dual Voltage Power Supply

Power Supply Capacitors

3.2.1.3 Lab - Ohm's Law

Answer the following questions based on electricity and Ohm's Law. Show all steps when solving problems.

a. What are the four basic units of electricity? Provide the variable name and symbol, and unit name and symbol.

b. Write the equation for Ohm's Law.

c. Re-arrange the Ohm's Law equation to solve the following:

I =

R =

d. Power is equal to voltage multiplied by current. Add the missing information in each of the following power equations.

P = V

P = R

$P = V^2$

e. The yellow wire connected to a power supply carries 12V. If the power supply provides 60W of power to the yellow wire, how much current is passing through the yellow wire?

f. There are 3.3V passing through an orange power supply cable, and there are 0.25 ohms of resistance in the orange wire. How much power is supplied to the orange wire by the power supply?

A wire from the power supply is carrying 120W of power and 24A of current. What is the voltage supplied to the wire by the power supply?

3.2.2 Power Fluctuation and Protection

3.2.2.1 Power Fluctuation Types

Voltage is a measure of energy required to move a charge from one location to another. The movement of electrons is called current. Computer circuits need voltage and current to operate electronic components. When the voltage in a computer is not accurate or steady, computer components might not operate correctly. Unsteady voltages are called power fluctuations.

The following types of AC power fluctuations can cause data loss or hardware failure:

- **Blackout** - Complete loss of AC power. A blown fuse, damaged transformer, or downed power line can cause a blackout.
- **Brownout** - Reduced voltage level of AC power that lasts for a period of time. Brownouts occur when the power line voltage drops below 80 percent of the normal voltage level and when electrical circuits are overloaded.
- **Noise** - Interference from generators and lightning. Noise results in poor quality power, which can cause errors in a computer system.
- **Spike** - Sudden increase in voltage that lasts for a short period and exceeds 100 percent of the normal voltage on a line. Spikes can be caused by lightning strikes, but can also occur when the electrical system comes back on after a blackout.
- **Power surge** - Dramatic increase in voltage above the normal flow of electrical current. A power surge lasts for a few nanoseconds, or one-billionth of a second.

3.2.2.2 Power Protection Devices

To help shield against power fluctuation problems, use devices to protect the data and computer equipment:

- **Surge protector** - Helps protect against damage from surges and spikes. A surge suppressor diverts extra electrical voltage that is on the line to the ground. The amount of protection offered by a surge protector is measured in joules. The higher the joule rating, the more energy over time the surge protector can absorb. Once the number of joules is reached, the surge protector no longer provides protection and will need to be replaced.
- **Uninterruptible power supply (UPS)** - Helps protect against potential electrical power problems by supplying a consistent level of electrical power to a computer or other device. The battery is constantly recharging while the UPS is in use. The UPS provides a consistent quality of power when brownouts and blackouts occur. Many UPS devices can communicate directly with the computer operating system. This communication allows the UPS to safely shut down the computer and save data prior to the UPS losing all battery power.
- **Standby power supply (SPS)** - Helps protect against potential electrical power problems by providing a backup battery to supply power when the incoming voltage drops below the normal level. The battery is on standby during normal operation. When the voltage decreases, the battery provides DC power to a power inverter, which converts it to AC power for the computer. This device is not as reliable as a

UPS because of the time it takes to switch over to the battery. If the switching device fails, the battery cannot supply power to the computer.

CAUTION: UPS manufacturers suggest never plugging a laser printer into a UPS because the printer could overload the UPS.

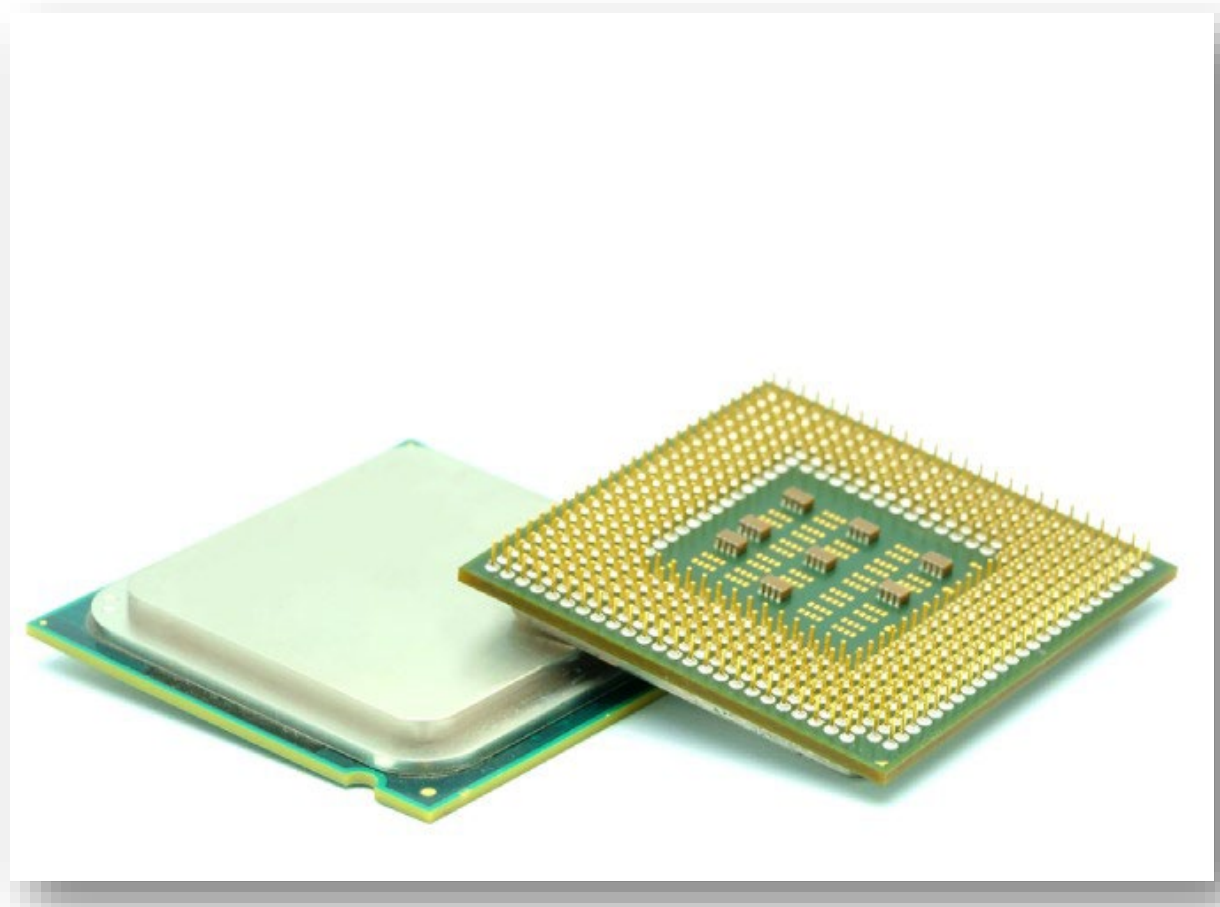
3.3.1.1 CPU Architectures

A program is a sequence of stored instructions. A CPU executes these instructions by following a specific instruction set.

There are two distinct types of instruction sets that CPUs may use:

- **Reduced Instruction Set Computer (RISC)** - This architecture uses a relatively small set of instructions. RISC chips are designed to execute these instructions very rapidly. Some well-known CPUs using RISC are PowerPC and ARM.
- **Complex Instruction Set Computer (CISC**) - This architecture uses a broad set of instructions, resulting in fewer steps per operation. Intel x86 and Motorola 68k are some well-known CPUs using CISC.

While the CPU is executing one step of the program, the remaining instructions and the data are stored nearby in a special, high-speed memory, called cache.



3.3.1.2 Enhancing CPU Operation

Various CPU manufacturers complement their CPU with performance-enhancing features. For instance, Intel incorporates Hyper-Threading to enhance the performance of some of their CPUs. With Hyper-Threading, multiple pieces of code (threads) are executed simultaneously in the CPU. To an operating system, a single CPU with Hyper-Threading performs as though there are two CPUs when multiple threads are being processed. AMD processors use HyperTransport to enhance CPU performance. HyperTransport is a high-speed connection between the CPU and the Northbridge chip.

The power of a CPU is measured by the speed and the amount of data that it can process. The speed of a CPU is rated in cycles per second, such as millions of cycles per second, called megahertz (MHz), or billions of cycles per second, called gigahertz (GHz). The amount of data that a CPU can process at one time depends on the size of the front side bus (FSB). This is also called the CPU bus or the processor data bus. Higher performance can be achieved when the width of the FSB increases, much like a roadway can carry more cars when it has many lanes. The width of the FSB is measured in bits. A bit is the smallest unit of data in a computer. Current processors use a 32-bit or 64-bit FSB.

Overclocking is a technique used to make a processor work at a faster speed than its original specification. Overclocking is not a recommended way to improve computer performance and can result in damage to the CPU. The opposite of overclocking is CPU throttling. CPU throttling is a technique used when the processor runs at less than the rated speed to conserve power or produce less heat. Throttling is commonly used on laptops and other mobile devices.

CPU virtualization is a hardware feature supported by AMD and Intel CPUs that enables a single processor to act as multiple processors. This hardware virtualization technology allows the operating system to support virtualization more effectively and efficiently than is possible through software emulation. With CPU virtualization multiple operating systems can run in parallel on their own virtual machines as if they were running on completely independent computers. CPU virtualization is sometimes disabled by default in the BIOS and will need to be enabled.

3.3.1.3 Multicore Processors

The latest processor technology has resulted in CPU manufacturers finding ways to incorporate more than one CPU core into a single chip. Multicore processors have two or more processors on the same integrated circuit. In some architectures, the cores have separate L2 and L3 cache resources, while in other architectures cache is shared among the different cores for better performance and resource allocation. The table in the figure describes the various types of multicore processors.

Integrating the processors on the same chip creates a very fast connection between them. Multicore processors execute instructions more quickly than single-core processors. Instructions can be distributed to all the processors at the same time. RAM is shared between the processors because the cores reside on the same chip. A multicore processor is recommended for applications such as video editing, gaming, and photo manipulation.

High-power consumption creates more heat in the computer case. Multicore processors conserve power and produce less heat than multiple single-core processors, thus increasing

performance and efficiency.

Another feature found in some CPUs is an integrated graphics processing unit or GPU. The GPU is a chip that performs the rapid mathematical calculations required to render graphics. A GPU can be integrated or dedicated. Integrated GPUs are often directly embedded on the CPU and is dependent on system RAM while the dedicated GPU is a separate chip with its own video memory dedicated exclusively for graphical processing. The benefit of integrated GPUs is cost and less heat dissipation. This allows for cheaper computers and smaller form factors. The trade off is performance. Integrated GPUs are good at less complex tasks like watching videos and processing graphical documents but are not best suited for intense gaming applications.

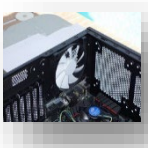
CPUs have also been enhanced using the NX bit, also called the execute disable bit. This feature, when supported and enabled in the operating system, can protect areas of memory that contain operating system files from malicious attacks by malware.

Number of Cores	**Description**
Single Core CPU	One core inside a single CPU that handles all the processing. A motherboard may have sockets for more than one single processor, providing the ability to build a powerful, multiprocessor computer.
Dual Core CPU	Two cores inside a single CPU in which both cores can process information at the same time.
Triple Core CPU	Three cores inside a single CPU. This is a quad-core processor with one of the cores disabled.
Quad Core CPU	Four cores inside a single CPU.
Hexa-Core CPU	Six cores inside a single CPU.
Octa-Core CPU	Eight cores inside a single CPU.

3.3.1.4 CPU Cooling Mechanisms

Case Fan

Increasing the air flow in the computer case allows more heat to be removed. An active cooling solution uses fans inside of a computer case to blow out hot air. For increased air flow, some cases have multiple fans with cool air being brought in while another fan is blowing out hot air.



CPU Heat Sink

The CPU generates a lot of heat inside the case. To draw heat away from the CPU core, a heat sink is installed on top of it, The heat sink has a large surface area with metal fins to dissipate heat into the surrounding air. This is known as passive cooling. Between the heat sink and the CPU is a special thermal compound. The thermal compound increases the efficiency of heat transfer from the CPU to the heat sink by filling any tiny gaps between the two.

CPU Fan

CPUs that are overclocked or running multiple cores tend to generate excessive heat. It is a very common practice to install a fan on top of the heat sink. The fan moves heat away from the metal fins of the heatsink. This is known as active cooling.

Graphics Card Cooling System

Other components are also susceptible to heat damage and are often equipped with fans. Video adapter cards have their own processor called a graphics-processing unit (GPU) which generates excessive heat. Video adapter cards also come equipped with one or more fans.

Water Cooling System

Computers with extremely fast CPUs and GPUs might use a water-cooling system. A metal plate is placed over the processor, and water is pumped over the top to collect the heat that the processor generates. The water is pumped to a radiator to disperse the heat into the air and the water is then recirculated. CPU fans make noise and can be annoying at high speeds. An alternative to cooling a CPU with a fan is a method that uses heat pipes. The heat pipe contains liquid that is permanently sealed at the factory and uses a system of cyclic evaporation and condensation.

3.3.2.2 RAID Concepts

Storage devices can be grouped and managed to create large storage volumes with redundancy. To do so, computers can implement redundant array of independent disks (RAID) technology. RAID provides a way to store data across multiple storage devices for availability, reliability, capacity, and redundancy and/or performance improvement. In addition, it may be more economical to create an array of smaller devices than it is to purchase a single device of the combined capacity provided by the RAID, especially for very large drives. To the operating system, a RAID array appears as one drive.

The following terms describe how RAID stores data on the various disks:

- **Striping** – This RAID type enables data to be distributed across multiple drives. This provides a significant performance increase. However, since the data is distributed across multiple drives, the failure of a single drive means that all data is lost.
- **Mirroring** – This RAID type stores duplicate data on one or more other drives. This provides redundancy so that the failure of a drive does not cause the loss of data. The Mirror can be recreated by replacing the drive and restoring the data from the good drive.
- **Parity** – This RAID type provides basic error checking and fault tolerance by storing checksums separately from data. This enables the reconstruction of lost data without sacrificing speed and capacity, like mirroring.
- **Double Parity** – This RAID type provides fault tolerance up to two failed drives.

The figure shows a large drive enclosure that could be used in a data center with one or more RAID implementations. Drive enclosures can use hot swappable drives. This means that a drive that fails can be replaced without powering down the entire RAID. Powering down the RAID may make the data on the RAID unavailable to users for an extended period of time. Not all drives and RAID types support hot swapping.

3.3.2.3 RAID Levels

There are several levels of RAID available. These levels use mirroring, striping, and parity in different ways. Higher levels of RAID, such as RAID 5 or 6, use striping and parity in combination to provide speed and to create large volumes. The figure shows the details about the RAID levels. RAID levels higher than 10 combine lower RAID levels. For example. RAID 10 combines RAID 1 and RAID 0 functionalities.

RAID Levels

RAID Level	Minimum Number of Drives	Features	Advantages	Disadvantages
0	2	Striping	Performance and Capacity.	All data is lost if one drive fails.
1	2	Mirroring	Performance and Reliability.	Capacity is half of total drive size.
5	3	Striping with parity	Performance, Reliability, and Capacity.	It takes time to rebuild array if a drive fails.
6	4	Striping with double parity	Same as RAID 5 but can tolerate the loss of two	It takes time to rebuild array if one or more

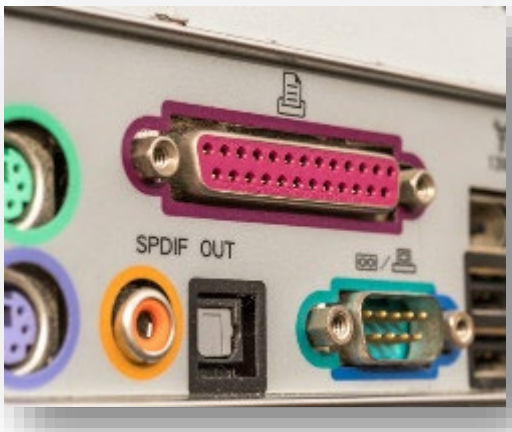
			drives.	drives fails.
10 (0+1)	4	Mirroring and Striping	Performance, Capacity, and High Reliability.	Capacity is half of total drive size.

3.3.3 Ports, Connectors, and Cables

3.3.3.1 Legacy Ports

Legacy Ports

Computers have many different types of ports to connect the computer to external peripheral devices. As computer technology has evolved, so have the types of ports used to connect peripheral devices. Legacy ports are typically found on older computers and have been mostly replaced by newer technologies such as USB.



Serial

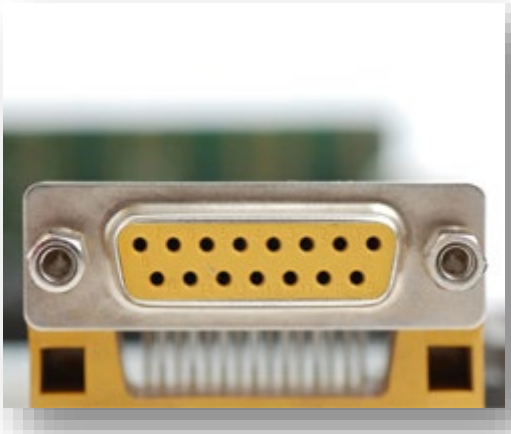
Serial ports were used to connect various peripherals such as printers, scanners, and modems. Today, serial ports are sometimes used for making console connections to network devices to perform initial configuration. There are two form factors of serial ports, a 9-pin DB-9 port and a 25-pin port.

Parallel

Parallel ports have a 25-pin receptacle used to connect various peripheral devices. As the name implies, parallel ports send data in multiple bits at once, in parallel communication. Because these ports were often used to connect printers, they are often called printer ports.

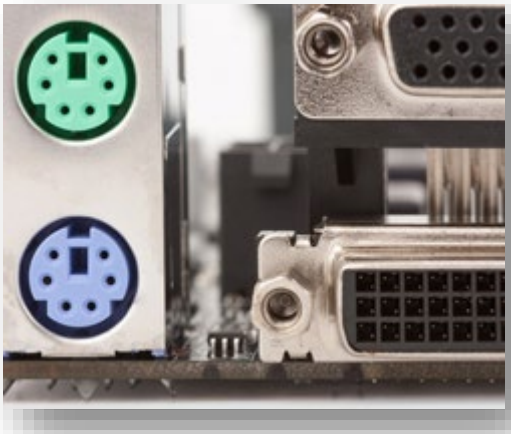
Game

The 15-pin game port was used as a connector for joystick input. Game ports were originally located on a dedicated game controller expansion card and then later integrated with sound cards and on PC motherboards.



PS/2

The PS/2 is a 6-pin din connector used for connecting a keyboard and mouse. Shown are two color-coded PS/2, purple for the keyboard and green for the mouse.



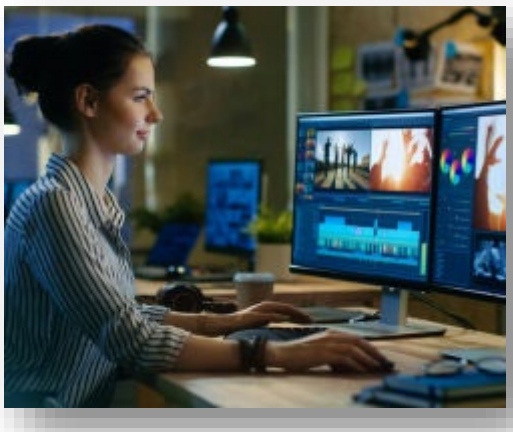
Audio ports

Audio ports connect audio devices to the computer. Analog ports typically include a line in port to connect to an external source (e.g., stereo system), a microphone port, and line out ports to connect speakers or headphones.

3.3.3.2 Video and Graphic Ports

Video and Graphic Ports

Graphic ports are used to connect monitors and external video displays to desktop computers and laptops.



VGA

VGA is an analog port and is the oldest graphics port likely still used on some PCs, although it is quickly becoming a legacy technology. VGA ports are colored blue and accept a 15-pin

connector, with the pins arranged in three rows.

DVI

The emergence of digital display such as LCD monitors and TVs led to the development of the DVI for transmitting uncompressed digital video. Variants of the DVI interface are configured to support multiple transmission modes. DVI-A (analog) supports analog only, DVI-D (digital) supports digital only, and DVI-I (integrated) supports both digital and analog. There are also two forms of DVI connections; single-link connections that use a single Transition Minimized Differential Signaling (TMDS) transmitter, and dual-link connections that use two TMDS transmitters to provide higher-resolutions to larger monitors.

HDMI

HDMI carries the same video information as DVI but is also capable of providing digital audio and control signals. HDMI uses a 19-pin connector. Smaller portable electronic devices have a smaller 19-pin Mini-HDMI port. HDMI is capable of very high resolutions. HDMI is also capable of changing the refresh rate of a monitor to match the rate of the source device output.

There are two categories of HDMI, 1 (Standard) and 2 (High Speed). There are also many versions of the HDMI standard such as v1.4. Newer versions of the standard support the latest features such as high refresh rates and 4K and 8K resolutions. Versions 2.0 and 2.1 can achieve very high speeds, 2.0 supports Premium High Speed up to 18 Gbps and 2.1 supports

Ultra High Speed up to 48 Gbps. A high-speed HDMI cable that supports at least HDMI 1.4, is required for supporting 4K signals.

HDMI connectors are available in three sizes: standard, mini and micro. The majority of HDMI connectors in use today are the Type A (Standard), Type C (Mini) and Type D (Micro).

DisplayPort

The DisplayPort is a newer technology designed to replace both DVI and VGA for connecting computer monitors. The DisplayPort uses a 20-pin connector for delivering high bandwidth video and audio signals. Like HDMI, there is a miniaturized version of the DisplayPort called the Mini DisplayPort which is primarily used on Apple computers.

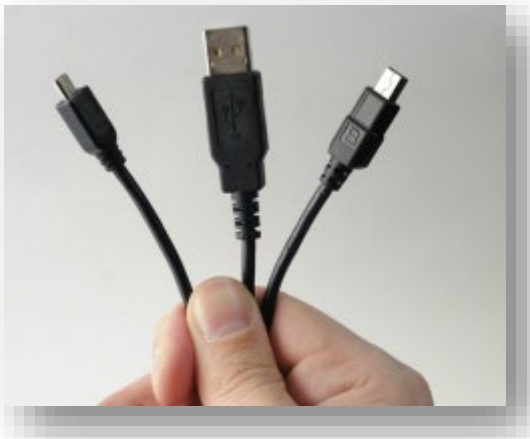
DisplayPort can handle up to 20 Gbps with version 2.0. DisplayPort is also capable of connecting multiple monitors to the same video source with a single cable.

3.3.3.3 USB Cables and Connectors

USB Cables and Connectors

Over the years, the USB protocol has evolved and the various standards can be confusing. USB 1.0 provided a low-speed transfer rate at 1.5 Mbps for keyboards and mice and a full-speed channel at 12 Mbps. USB 2.0 made a significant leap, increasing transfer rates up to High Speed at 480 Mbps. USB 3.0 increased the transfer rate to SuperSpeed 5 Gbps, USB 3.1

increased the transfer rate of SuperSpeed to 10 Gbps, and USB 3.2, the latest USB-C specification supports speeds of up to SuperSpeed+ 20 Gbps.



USB Type-A

This is a rectangular connector found on virtually every desktop PC and laptop, as well as TVs, game consoles, and media players. USB 1.1, 2.0, and 3.0 Type-A connectors and receptacles are physically compatible.

Mini-USB

The USB Mini-B connector is rectangular with a small indention on each side. The Mini-USB form factor is being phased out and replaced by the micro-USB connector.

Micro-USB

The Micro-USB connector is found on smartphones, tablets, and other devices. Except for Apple, most manufacturers have adopted the Micro-USB interface. The USB 2.0 Micro-B connector has two corners pushed in at an angle.

USB Type-B

The USB Type-B connector is commonly used to connect printer and external hard drives. It has a square shape with beveled exterior corners and an extra notch at the top.

USB Type-C

The USB Type-C connector is the newest USB interface. It is smaller than the Type-A connector and is rectangular with four rounded corners. Both Thunderbolt 3 and USB Type-C are an example of a multipurpose cable that can be used to attach different kinds of peripheral devices to a PC. USB Type C is the shape of the port. Thunderbolt 3 combines the functionality of USB, Thunderbolt, DisplayPort, and the ability to deliver power to devices through the cable.

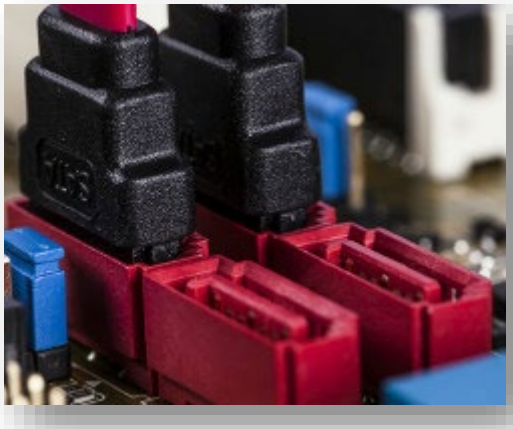
Lightning

The Lightning connector is a small proprietary 8-pin connector used by Apple mobile devices such as iPhones, iPads, and iPods for both power charging and data transfer. It is similar in appearance to a USB Type-C connector.

3.3.3.4 SATA Cables and Connectors

SATA Cables and Connectors

SATA is an interface type used connect SATA hard drives and other storage devices to the motherboard inside the computer. SATA cables are long (up to 1 meter) and thin with a flat and thin 7-pin connector on each end.

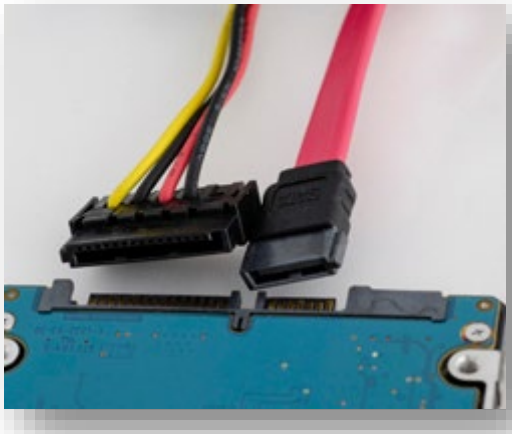


SATA Cable and Connector

One end plugs into a SATA port on the motherboard and the other end into the back of an internal storage device such as a SATA hard drive. The SATA connecter has an “L” shaped key so that it can only be installed in one way.

SATA Data and Power Cables

The SATA cable does not provide power so an addition cable is needed to supply power to SATA drives.



eSATA Cable

eSATA is used to connect external SATA drives. eSATA connectors do not have an “L” shaped key like the SATA connector. However, an eSATA port does have a key feature to prevent inadvertent insertion of a USB connector, which is similar in size and shape.

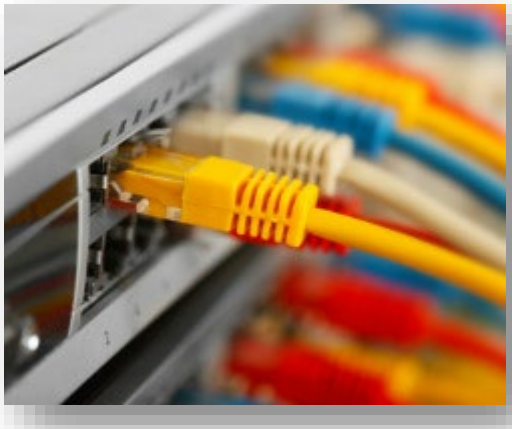
eSATA Adapter Card

Often, an expansion card is installed in the computer to provide eSATA ports.

3.3.3.5 Twisted Pair Cables and Connectors

Twisted Pair Cables and Connectors

Twisted pair cable is used in wired Ethernet networks and in older telephone networks. Twisted pair cabling gets its name from the fact that pairs of wires inside the cable are twisted together. The twisting of wire pairs helps reduce crosstalk and electromagnetic induction.



RJ-45 Connector

Each end of a UTP cable must be terminated with a connector. In the case of Ethernet networks, it is an RJ-45 connector that terminates the cable and is plugged into an Ethernet port.

Twisted Pairs

There are basically two types of twisted pair cables: Unshielded Twisted Pair (UTP) cabling and Shielded Twisted Pair (STP). The most commonly used form of twisted pair cabling is UTP. It consists of color-coded insulated copper wires without the foil or braiding found in STP.

RJ-11 Connector

Older telephone networks used a four-wire UTP cable with two wire pairs terminated with a 6-pin RJ-11 connector. The RJ-11 connector looks very similar to the RJ-45 connector but is smaller.

3.3.3.6 Coax Cables and Connectors

Coax Cables and Connectors

Coaxial cable has an inner center conductor, usually made from copper or copper-clad-steel, which is surrounded by a non-conductive dielectric insulating material. The dielectric is surrounded by a foil shield which forms the outer conductor and shields against electromagnetic interference (EMI). The outer conductor/shield is encased in a PVC outer jacket.

Coax Cable Construction

Coax cable with the outer jacket pulled back to reveal the braided shielding and copper core conductor.

RG-6

RG-6 cable is heavy gauge and has insulation and shielding tuned for high-bandwidth, high-frequency applications such as Internet, Cable TV, and Satellite TV signals. RG-6 commonly uses an F-Type connector, as shown in the figure.

RG-59

RG-59 cable is thinner than RG-6 and has less shielding. RG-59 is recommended in low bandwidth and lower frequency applications such as analog video and CCTV applications. RG-59 commonly uses a BNC connector as shown in the next figure.

BNC

BNC connectors connect coaxial cables to devices using a quarter-turn connection scheme. BNC is used with digital or analog audio, or video.

3.3.3.7 SCSI and IDE Cables and Connectors

SCSI Cables and Connectors

Small Computer Systems Interface (SCSI) is a standard for connecting peripheral and storage devices. SCSI is a bus technology, meaning that all devices connect to a central bus and are "daisy-chained" together. The cabling/connector requirements depend upon the location of the SCSI bus.

Integrated Drive Electronics (IDE) is a standard type of interface used to connect some hard drives and optical drives to each other and to the motherboard.

External SCSI Cable

The Centronics connector is used for connecting older external SCSI devices such as scanners and printers. This connector came in 36-pin and 50-pin versions. The pins are arranged in two rows with a plastic bar through the center that holds the contact pins. Squeeze latches or bail locks located on the sides of the connector are used to hold it in place.

Internal SCSI Cable

A common SCSI connector for internal hard drives is the internal 50-pin SCSI which has 50 pins arranged in two rows and is attached to a ribbon cable.

IDE Cable

IDE ribbon cables look very similar to internal SCSI cables however IDE uses 40-pin connectors. There are typically three connectors on the cable. One to connect to the IDE port on the motherboard and two for attachment of IDE drives.

3.3.4 Monitors

3.3.4.1 Monitor Characteristics

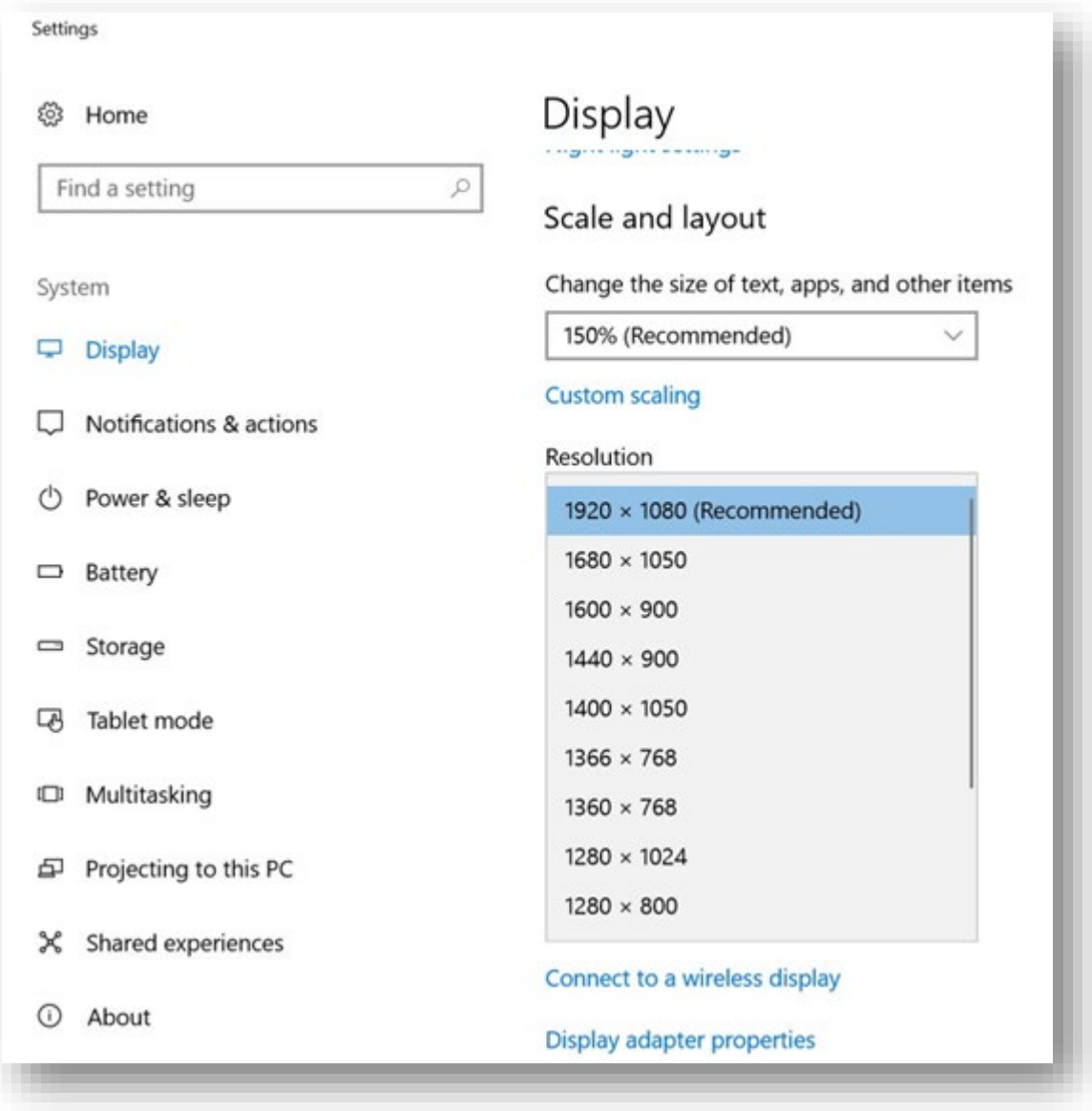
There are many types of computer monitors available. Some are designed for casual use, while others are for specific requirements, such as those used by architects, graphic designers, or even gamers.

Monitors vary by use, size, quality, clarity, brightness and more. Therefore, it is useful to understand the various terms used when discussing monitors.

Computer monitors are usually described by:

- **Screen size** – This is the diagonal measurement of the screen (i.e., top left to bottom right) in inches. Common sizes include 19 to 24 inches, to ultrawide monitors that are 30 or more inches wide. Larger monitors are usually better but are more expensive and require more desk space.
- **Resolution** – Resolution is measured by the number of horizontal and vertical pixels. For example, 1920 x 1080 (i.e., 1080p) is a common resolution. This means it has 1920 horizontal pixels and 1080 vertical pixels.
- **Monitor resolution** – This relates to the amount of information that can be displayed on a screen. A higher resolution monitor displays more information on a screen than a lower resolution monitor does. This is true even with monitors that have the same screen size.
- **Native resolution** – This identifies the best monitor resolution for the specific monitor. In Windows 10, the native resolution of a monitor is identified using the keyword (Recommended) beside the monitor resolution. For example, in the figure, the native resolution of the monitor is 1920 x 1080.
- **Native mode** – This term describes when the image sent to the monitor by the video adapter card matches the native resolution of the monitor.
- **Connectivity** – Older monitors used VGA or DVI connectors while newer monitors support HDMI and DisplayPort ports. DisplayPort is a connection found on newer monitors. It supports higher resolutions and high refresh rates.

Note: If you want to display more things on the screen, then select a higher resolution monitor. If you just want things to appear bigger, then select a larger screen size.



3.3.4.2 Monitor Terms

Pixel

- Abbreviation for “picture element” and is a tiny dot capable of displaying the shades red, green, and blue (RGB).
- More pixels mean the monitor can display more detail.

Dot pitch

- This is the distance between pixels on the screen.
- A lower dot pitch (i.e., a smaller distance between dots) produces a better image.

Brightness

- Describes the luminance of a monitor measured in candelas per square meter (cd/m2).
- Brightness up to 250 cd/m2 is typically recommended, however, in well-lit rooms, use up to 350 cd/m2.

Note: Too much brightness may cause eyestrain.

Contrast ratio

- This is a measurement of how white and how black a monitor can get.
- A contrast ratio of 1,000:1 displays dimmer whites and more pale blacks than 4,500:1.

Aspect ratio

- Aspect ratio is the horizontal to vertical measurement of the viewing area of a monitor.

For example, QSXGA measures 2,560 pixels horizontally by 2,048 pixels vertically, which creates an aspect ratio of 5:4. If a viewing area was 16 inches wide by 12 inches high, then the aspect ratio would be 4:3. A viewing area that is 24 inches wide by 18 inches high also has an aspect ratio of 4:3.

Refresh rate

- Expressed in Hertz (Hz) and refers to how often per second your monitor can redraw the screen.

Response time

- The amount in time for a pixel to change properties (i.e., color or brightness).
- Fast response times display a smooth image when displaying fast action

Frames per second (fps)

- FPS is is how many times the computer is creating each frame. The higher the FPS, the better, but the monitor must be able to display the frames at the high rate.

Interlaced / Non-Interlaced

- Interlaced monitors create the image by scanning the screen two times. The first scan covers the odd lines, top to bottom, and the second scan covers the even lines.
- Non-interlaced monitors create the image by scanning the screen, one line at a time from top to bottom.

3.3.4.3 Display Standards

CGA

Resolution	Aspect Ratio	Comment
320 x 200	16:10	• Color Graphics Adapter • Introduced by IBM in 1981 • Obsolete

VGA

Resolution	Aspect Ratio	Comment

640 x 480	4:3	• Video Graphics Array • Introduced in 1987 • Legacy

SVGA

Resolution	Aspect Ratio	Comment
800 x 600	4:3	• Super Video Graphics Array • Introduced in 1989 • Still supported on some platforms

HD

Resolution	Aspect Ratio	Comment
1280 X 720	16:9	• High Definition • Also known as 720p

FHD

Resolution	Aspect Ratio	Comment
1920 x 1080	16:9	• Full High Definition • Also known as 1080p • Good setting for typical user

QHD

Resolution	Aspect Ratio	Comment
2560 x 1440	16:9	• Quad High Definition • Also known as 1440p • Suggested resolution for high-end users and gamers

UHD

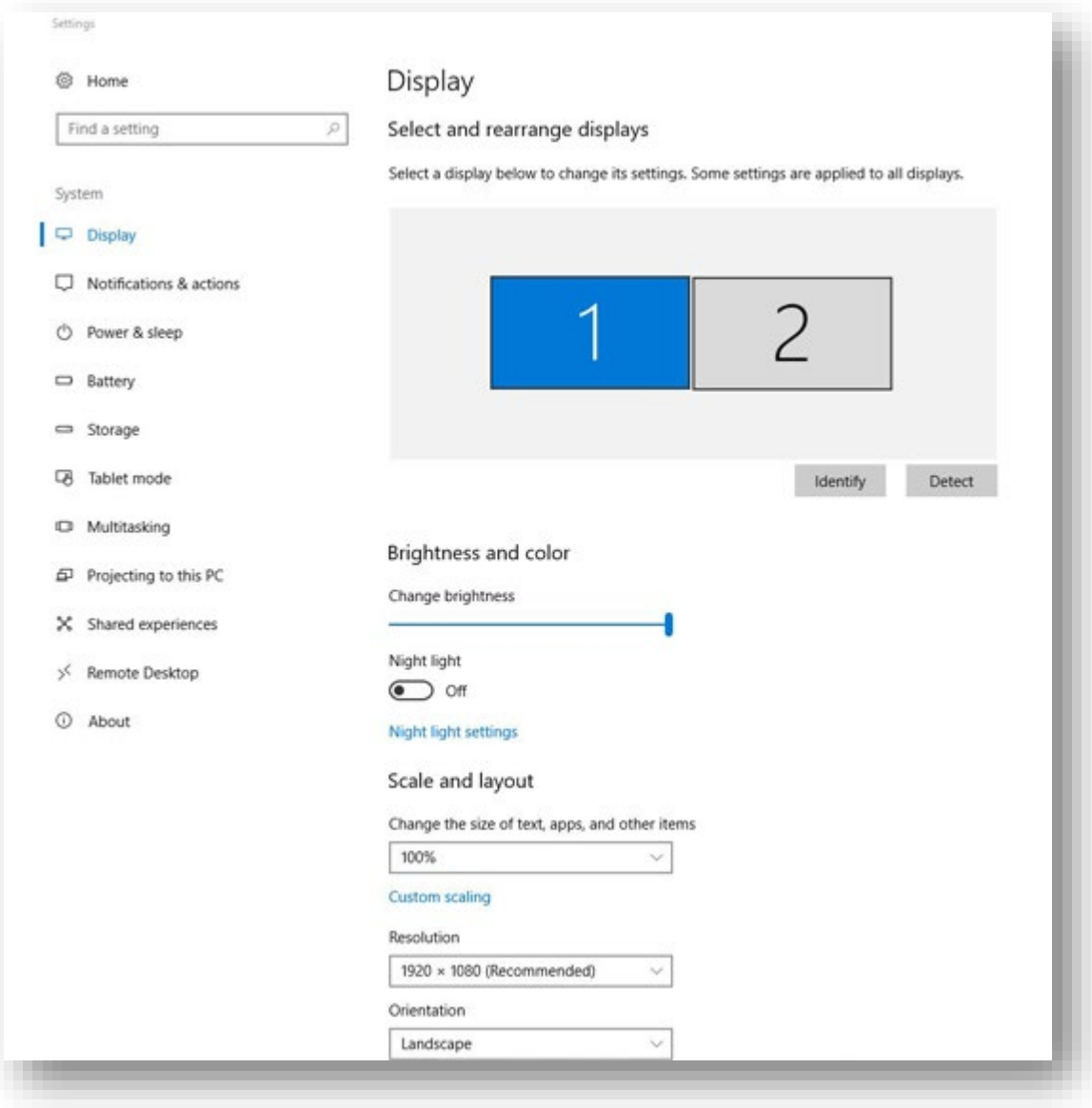
Resolution	Aspect Ratio	Comment
3840 x 2160	16:9	• Ultra High Definition • Also known as 4K

3.3.4.4 Using Multiple Monitors

Adding monitors can increase your visual desktop area and improve productivity. The added monitors enable you to expand the size of the monitor or duplicate the desktop so you can view additional windows. For example, the woman in the figure below is using multiple displays. She is using the right monitor to make changes to a website and the left monitor to display the resulting change. She is also using a laptop to display a library of images she is considering for inclusion in the website.

Many computers have built-in support for multiple monitors. To connect multiple monitors to a computer, you need the supporting cables. Then you need to enable your computer to support multiple monitors.

For example, on a Windows 10 host, right-click anywhere on the Desktop and choose **Display settings**. This should open the Display window as shown in the figure. In the example, the user has two monitors connected in the configuration displayed. The current monitor selected is in blue and has a resolution of 1920 x 1080. It is also the main display monitor. Clicking on monitor 2 would display its resolutions.



3.4.1 Upgrade Computer Hardware

3.4.1.1 Motherboard Upgrade

Computers need periodic upgrades for various reasons:

- User requirements change
- Upgraded software packages require new hardware
- New hardware offers enhanced performance

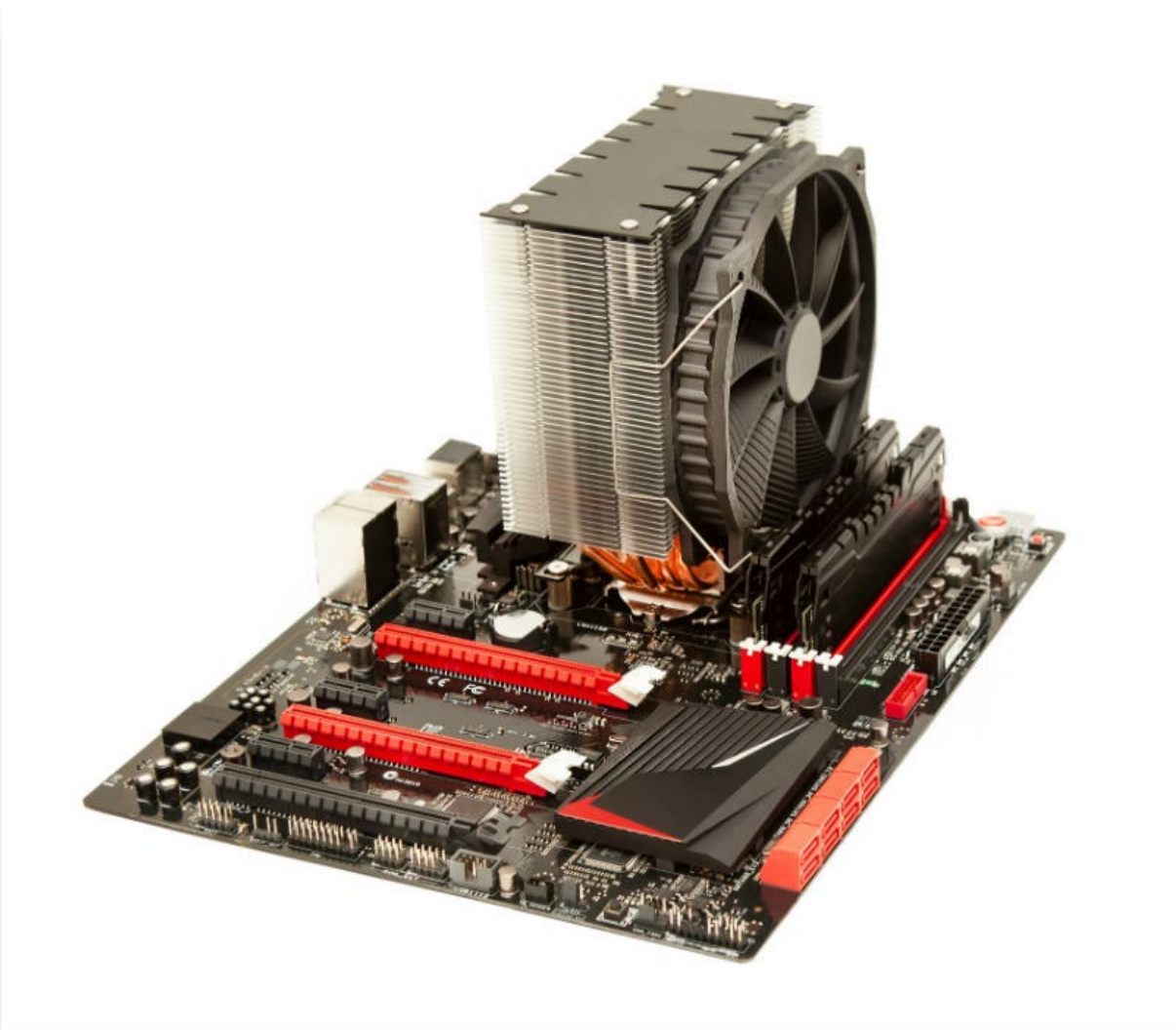
Changes to the computer may cause you to upgrade or replace components and peripherals. Research the effectiveness and cost of both upgrading and replacing.

If you upgrade or replace a motherboard, consider that you might have to replace other components including the CPU, heat sink and fan assembly, and RAM. A new motherboard must also fit into the old computer case and the power supply must support it.

When upgrading the motherboard, begin the upgrade by moving the CPU and the heat sink and fan assembly to the new motherboard if they will be reused. These items are much easier

to work with when they are outside of the case. Work on an antistatic mat, and wear antistatic gloves or an antistatic wrist strap to avoid damaging the CPU. If the new motherboard requires a different CPU and RAM, install them at this time. Clean the thermal compound from the CPU and heat sink. Remember to re-apply thermal compound between the CPU and the heat sink.

In the figure, select the components that are impacted by a motherboard upgrade.



3.4.1.2 Steps to Upgrade a Motherboard

Before beginning an upgrade, ensure that you know where and how everything is connected. Always make notes in a journal to record how the current computer is set up. A quick way is to use a cell phone and take pictures of important items such as how components connect to the motherboard. These pictures may prove to be surprisingly helpful when re-assembling.

To upgrade a motherboard from a computer case, follow these steps:

Step 1. Record how the power supply, case fans, case LEDs, and case buttons attach to the old motherboard.

Step 2. Disconnect the cables from the old motherboard.

Step 3. Disconnect the expansion cards from the case. Remove each expansion card and place them in antistatic bags, or on an antistatic mat.

Step 4. Carefully record how the old motherboard is secured to the case. Some mounting screws provide support while some may provide an important grounding connection between the motherboard and chassis. In particular, pay attention to screws and standoffs that are non-metallic, because these may be insulators. Replacing insulating screws and supports with metal hardware that conducts electricity might damage electrical components.

Step 5. Remove the old motherboard from the case.

Step 6. Examine the new motherboard and identify where all of the connectors are such as power, SATA, fan, USB, audio, front panel connector, and any others.

Step 7. Examine the I/O shield located at the back of the computer case. Replace the old I/O shield with the I/O shield that comes with the new motherboard.

Step 8. Insert and secure the motherboard into the case. Be sure to consult the case and motherboard manufacturer user guides. Use the proper types of screws. Do not swap threaded screws with self-tapping metal screws, because they will damage the threaded screw holes and might not be secure. Make sure that the threaded screws are the correct length and have the same number of threads per inch. If the thread is correct, they fit easily. If you force a screw to fit, you can damage the threaded hole, and it will not hold the motherboard securely. Using the wrong screw can also produce metal shavings that can cause short circuits.

Step 9. Next, connect the power supply, case fans, case LEDs, front panel, and any other required cables. If the ATX power connectors are not the same size (some have more pins than others), you might need to use an adapter. Refer to the motherboard documentation for the layout of these connections.

Step 10. After the new motherboard is in place and the cables are connected, install and secure the expansion cards.

It is now time to check your work. Make sure that there are no loose parts or unconnected cables. Connect the keyboard, mouse, monitor, and power. If a problem is detected, shut the power supply off immediately.

3.4.1.3 CPU Upgrade

One way to increase the power of a computer is to increase the processing speed. You can do this by upgrading the CPU. However, the CPU must meet the requirements listed in the figure.

The new CPU might require a different heat sink and fan assembly. The assembly must physically fit the CPU and be compatible with the CPU socket. It must also be adequate to remove the heat of the faster CPU.

CAUTION: You must apply thermal compound between the new CPU and the heat sink and fan assembly.

View thermal settings in the BIOS to determine if there are any problems with the CPU and the heat sink and fan assembly. Third-party software applications can also report CPU temperature information in an easy-to-read format. Refer to the motherboard or CPU user documentation to determine if the chip is operating in the correct temperature range.

To install additional fans in the case to help cool the computer, follow these steps:

Step 1. Align the fan so that it faces the correct direction to either draw air in or blow air out.

Step 2. Mount the fan using the predrilled holes in the case. It is common to mount fans near the top of the case to blow hot air out, and near the bottom of the case to bring air in. Avoid mounting two fans close together that are moving air in opposite directions.

Step 3. Connect the fan to the power supply or the motherboard, depending on the case fan plug type.

Requirements

- The new CPU must fit into the existing CPU socket.
- The new CPU must be compatible with the motherboard chipset.
- The new CPU must operate with the existing motherboard and power supply.

3.4.1.4 Storage Device Upgrade

Instead of purchasing a new computer to get faster speed and more storage space, you might consider adding another hard drive. There are several reasons for installing an additional drive as listed in the figure.

After selecting the appropriate hard drive for the computer, follow these general guidelines during installation:

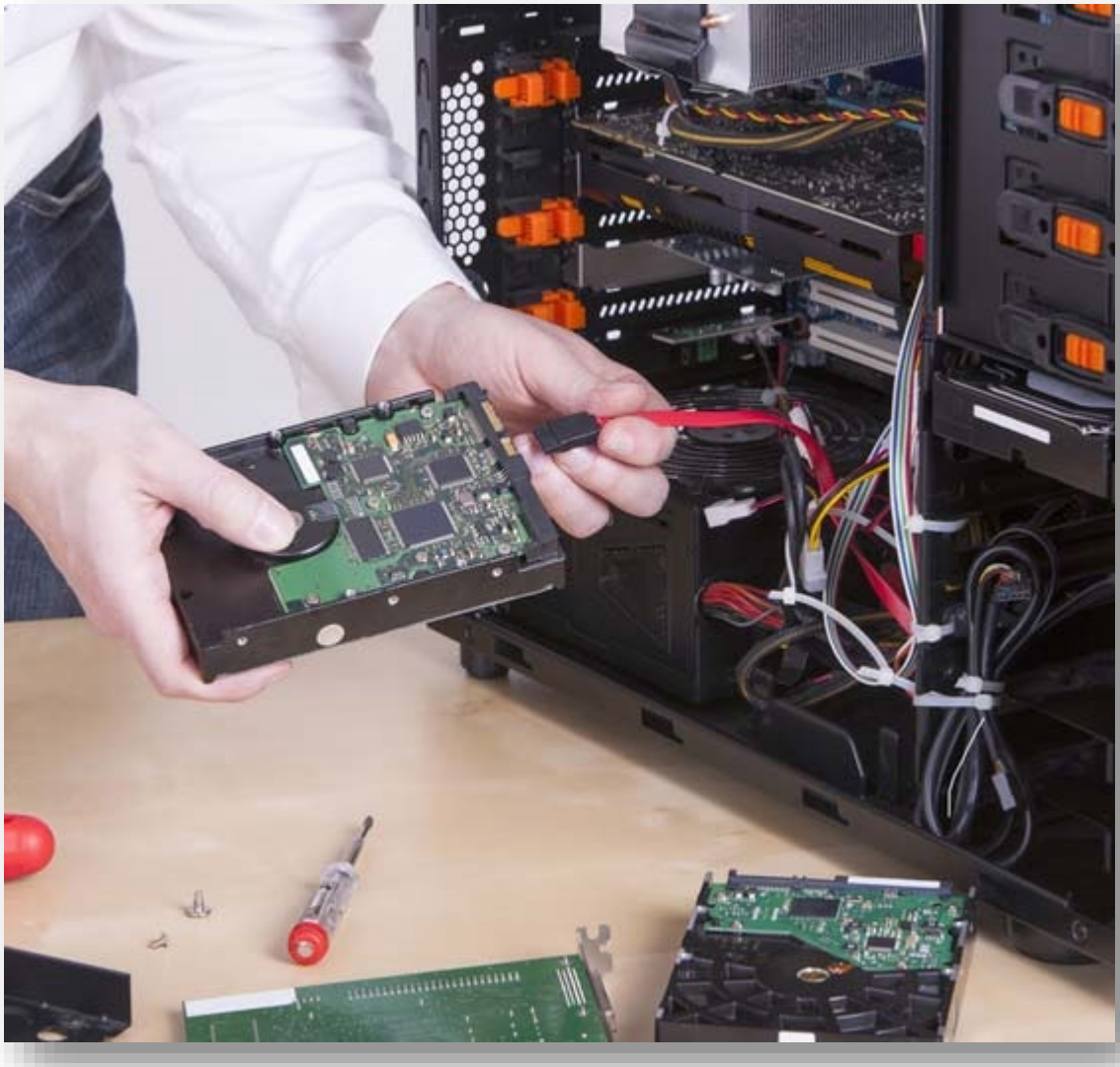
Step 1. Place the hard drive in an empty drive bay, and tighten the screws to secure the hard drive.

Step 2. Connect the drive to the motherboard using the correct cable.

Step 3. Attach the power cable to the drive.

Reasons for New Drive

- Increase storage space
- Increase hard drive speed
- Install a second operating system
- Store the system swap file
- Provide fault tolerance
- Back up the original hard drive



3.4.1.5 Peripheral Upgrades

Peripheral devices periodically need to be upgraded. For example, if the device stops operating or if you wish to improve performance and productivity, an upgrade might be necessary.

These are a few reasons for upgrading a keyboard and/or a mouse:

- Change the keyboard and mouse to an ergonomic design such as those shown in the figure below. Ergonomic devices are made to be more comfortable to use and to help prevent repetitive motion injuries.
- Reconfigure the keyboard to accommodate a special task, such as typing in a second language with additional characters.
- To accommodate users with disabilities.

However, sometimes it is not possible to perform an upgrade using the existing expansion slots or sockets. In this case, you may be able to accomplish the upgrade using a USB connection. If the computer does not have an extra USB connection, you must install a USB adapter card or purchase a USB hub, as shown below.

3.4.1.6 Power Supply Upgrade

Upgrading your computer hardware will most likely also change its power needs. If so, you

may need to upgrade your power supply. You can find calculators on the internet to help you determine if you need to upgrade the power supply. Search for “power supply wattage calculator”.

In addition to upgrading for additional power, a computer may be capable of having two power supplies. One acts as a redundant power supply in case of failure. A special motherboard must be used to take advantage of this configuration. This configuration is not often found with desktop computers. It is more commonly used in servers. This allows both power supplies to be hot-swappable. The faulty power supply can be replaced without losing power to the computer.

3.4.1.7 Lab - Research a Hardware Upgrade

Introduction

Use the Internet, a newspaper, or a local store to gather information about hardware components. Your

customer’s computer currently has one module of 2 GB of RAM, a 500 GB hard disk drive, and a PCIe video adapter card with 256 MB of RAM. Your customer wants to be able to play advanced video games.

Instructions

Step 1: Research memory options.

Shop around, and in the table below list the brand, model number, features, and cost for two different 8 GB modules of DDR3.

Brand and Model Number	Features	Cost

Question:

Based on your research, which RAM would you select? Be prepared to discuss your decisions regarding the RAM you select.

Step 2: Research hard disk drive options.

Shop around, and in the table below list the brand, model number, features, and cost for a 3 TB 7200 rpm SATA 3 hard disk drive and a 500GB or 1TB solid state drive (SSD).

Brand and Model Number	Features	Cost

Question:

Based on your research, which hard disk drive would you select? Be prepared to discuss your decisions regarding the hard disk drive you select.

Step 3: Research video adapter card options.

Shop around, and in the table below list the brand, model number, features, and cost for two different PCIe video adapter cards with at least 1 GB of RAM.

Brand and Model Number	Features	Cost

Question:

Based on your research, which video adapter card would you select? Be prepared to discuss your decisions regarding the video adapter card you select.

3.5.1 Safe Disposal of Equipment and Supplies

3.5.1.1 Safe Disposal Methods

After upgrading a computer, or replacing a broken device, what do you do with the leftover parts? If the parts are still good, they can be donated or sold. Parts that no longer work must be disposed of, but they must be disposed of responsibly.

The proper disposal or recycling of hazardous computer components is a global issue. Make sure to follow regulations that govern how to dispose of specific items. Organizations that violate these regulations can be fined or face expensive legal battles. Regulations for the

disposal of the items on this page vary from state to state and from country to country. Check your local environmental regulatory agency.

Batteries

Batteries often contain rare earth metals that can be harmful to the environment. These metals do not decay and remain in the environment for many years. Mercury is commonly used in the manufacturing of batteries and is extremely harmful to humans.

Recycling batteries should be standard practice. All batteries are subject to disposal procedures that comply with local environmental regulations.

Monitors

Handle CRT monitors with care. Extremely high voltage can be stored in CRT monitors, even after being disconnected from a power source.

Monitors contain glass, metal, plastics, lead, barium, and rare earth metals. According to the U.S. Environmental Protection Agency (EPA), monitors can contain approximately 4 pounds (1.8 kg) of lead. Monitors must be disposed of in compliance with environmental regulations.

Toner Kits, Cartridges, and Developers

Used printer toner kits and printer cartridges must be disposed of properly in compliance with environmental regulations. They can also be recycled. Some toner cartridge suppliers and manufacturers take empty cartridges for refilling. Kits to refill inkjet printer cartridges are available but are not recommended, because the ink might leak into the printer, causing irreparable damage. Using refilled inkjet cartridges might also void the inkjet printer warranty.

Chemical Solvents and Aerosol Cans

Contact the local sanitation company to learn how and where to dispose of the chemicals and solvents used to clean computers. Never dump chemicals or solvents down a sink or dispose of them in a drain that connects to public sewers.

Cell Phones and tablets

The EPA recommends individuals check with local health and sanitation agencies for their preferred way to depose of electronics such as cell phones, tablets, and computers. Most computer equipment and mobile devices contain hazardous materials, such as heavy metals, that do not belong in a landfill because they contaminate the earth. Local communities may also have recycling programs.

3.5.1.2 Safety Data Sheets

Hazardous materials are sometimes called toxic waste. These materials can contain high concentrations of heavy metals such as cadmium, lead, or mercury. The regulations for the disposal of hazardous materials vary by state or country. Contact the local recycling or waste removal authorities in your community for information about disposal procedures and services.

A Safety Data Sheet (SDS), formerly known as a Material Safety and Data Sheet (MSDS), is a fact sheet that summarizes information about material identification, including hazardous ingredients that can affect personal health, fire hazards, and first-aid requirements. The SDS contains chemical reactivity and incompatibility information. It also includes protective measures for the safe handling and storage of materials and spill, leak, and disposal procedures. To determine if a material is classified as hazardous, consult the manufacturer's SDS which in the U.S. is required by OSHA when the material is transferred to a new owner.

The SDS explains how to dispose of potentially hazardous materials in the safest manner. Always check local regulations concerning acceptable disposal methods before disposing of any electronic equipment.

In the European Union, the regulation Registration, Evaluation, Authorization and restriction of Chemicals (REACH) came into effect on June 1, 2007, replacing various directives and regulations with a single system.

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Back to Hazard Communications
OSHA Brief
Hazard Communication Standard: Safety Data Sheets
The Hazard Communication Standard (HCS) (29 CFR 1910.1200(g)), revised in 2012, requires that the chemical manufacturer, distributor, or importer provide Safety Data Sheets (SDSs) (formerly MSDSs or Material Safety Data Sheets) for each hazardous chemical to downstream users to communicate information on these hazards. The information contained in the SDS is largely the same as the MSDS, except now the SDSs are required to be presented in a consistent user-friendly, 16-section format. This brief provides guidance to help workers who handle hazardous chemicals to become familiar with the format and understand the contents of the SDSs.
The SDS includes information such as the properties of each chemical; the physical, health, and environmental health hazards; protective measures; and safety precautions for handling, storing, and transporting the chemical. The information contained in the SDS must be in English (although it may be in other languages as well). In addition, OSHA requires that SDS preparers provide specific minimum information as detailed in Appendix D of 29 CFR 1910.1200. The SDS preparers may also include additional information in various section(s).
Sections 1 through 8 contain general information about the chemical, identification, hazards, composition, safe handling practices, and emergency control measures (e.g., fire fighting). This information should be helpful to those that need to get the information quickly. Sections 9 through 11 and 16 contain other technical and scientific information, such as physical and chemical properties, stability and reactivity information, toxicological information, exposure control information, and other information including the date of preparation or last revision. The SDS must also state that no applicable information was found when the preparer does not find relevant information for any required element.
The SDS must also contain Sections 12 through 15, to be consistent with the UN Globally Harmonized System of Classification and Labeling of Chemicals (GHS), but OSHA will not enforce the content of these sections because they concern matters handled by other agencies.

3.6.1 Conclusion

3.6.1.1 Chapter 3: Advanced Computer Hardware

In this chapter, you learned about the computer boot process and the role played by the BIOS which performs the POST on the main components of the computer. You also learned that the motherboard BIOS settings are saved in a CMOS memory chip. When a computer boots, the BIOS software reads the configured settings stored in CMOS to determine how to configure the hardware. In the lab, you installed Microsoft Windows operating system and third-party software.

After installing Windows, you learned about Wattage and Voltage and the basic equation of Ohm's Law, which expresses how voltage is equal to the current multiplied by the resistance: V = IR and that power is equal to the voltage multiplied by the current: P = VI. You learned about the types of AC power fluctuations that can cause data loss or hardware failure like blackouts, brownouts, noise, spikes and power surges. You also learned about the devices that help shield against power fluctuation problems and protect the data and computer equipment. These devices include surge protectors, UPS, and SPS.

Next, you learned about multicore processors ranging from dual core CPUs with two cores inside a single CPU, to Octa-core CPUs with eight cores inside a single CPU, and different types of CPU cooling mechanisms like fans, heat sinks, and water cooling systems. In addition to multicore CPUs, you learned how multiple drives can be logically grouped and managed to create large storage volumes with redundancy using RAID technology. Striping, mirroring, parity, and double parity types of RAID were covered.

You learned about many different types of computer ports and connectors starting with legacy ports that are typically found on older computers such as serial, parallel, game, PS/2 and audio ports - most of which are replaced by newer technologies like USB. You also

learned about various video and game ports like VGA, DVI, HDMI and display ports used to connect monitors and external video displays. The evolution of USB ports was covered as well and included comparisons of USB Type-A, mini-USB, micro-USB, USB Type-B, USB Type-C, and lightning connectors.

The characteristics that define computer monitors was covered. You learned that monitors vary by use, size, quality, clarity, and brightness. You also learned that monitors are described by their screen size as measured diagonally and screen resolution as measured by the number of pixels. Display standards of CGA, VGA, SVGA, HD, FHD, QHD and UHD were all defined as well.

The chapter concluded with a discussion on protecting the environment through safe disposal methods for computer components. You learned that their are regulations for the disposal of many of these components such as batteries, toner, printer cartridges, cell phones, and tablets. You also learned about the SDS which explains how to dispose of potentially hazardous materials in the safest manner. Always check local regulations concerning acceptable disposal methods before disposing of any electronic equipment.